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NOTE.

This report consists of three parts, namely:

Part I. Field work, classification of coals, chemical work (pp. 1-300).

Part II. Boiler tests (pp. 301-979).

Part III. Producer-gas, coking, briquetting, and washing tests (pp. 981-1473).

Part I contains also a general table of contents, a list of illustrations, and an introduction. An index to the report appears at the end of Part III.

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
COAL-TESTING PLANT, WORLD'S FAIR GROUNDS,
St. Louis, Mo., August 10, 1905.

SIR: The undersigned, composing the committee appointed by you to conduct the operations of the United States Geological Survey coal-testing plant at the Louisiana Purchase Exposition, St. Louis, Mo., have the honor to submit the following report on the work committed to their charge. This report contains the full details of the installation of the plant, its operations, and the results obtained, with numerous illustrations by photographs, drawings, diagrammatic charts, etc. The plant was started September 1, 1904, and was kept in operation, except for a shut-down for the Christmas holidays, until February 25, 1905. The work done after the close of the exposition, on December 1, 1904, was carried on for the purpose of finishing up some tests of coal on hand or received after that date, and delayed in transit.

A preliminary report giving a summary of the results obtained up to December 22, 1904, was submitted to you January 31, 1905, and published as Bulletin No. 261 in February.

Very respectfully,

E. W. PARKER,
J. A. HOLMES,
M. R. CAMPBELL,
Committee.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

REPORT ON THE OPERATIONS OF THE COAL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO., 1904.

EDWARD W. PARKER,
JOSEPH A. HOLMES,
MARIUS R. CAMPBELL,
Committee in Charge.

INTRODUCTION.

By EDWARD W. PARKER.

ORGANIZATION.

The authority for conducting at the Louisiana Purchase Exposition an investigation of the coals and lignites of the United States is contained in the act of Congress providing for the urgent deficiencies in the appropriations for the fiscal year 1905, and approved February 18, 1904, as follows:

> For analyzing and testing at the Louisiana Purchase Exposition the coals and lignites of the United States, in order to determine their fuel values and the most economical method for their utilization for different purposes, under the supervision of the Director of the United States Geological Survey, thirty thousand dollars, to be available until expended: *Provided,* That all testing machinery and all coals and lignites to be tested shall be contributed without charge to the Government.

In the general deficiency bill approved April 27, 1904, an additional appropriation of $30,000 was provided, making the total sum appropriated for this work $60,000.

For carrying out the provisions of these acts the Director of the Geological Survey appointed a committee, consisting of Edward W. Parker, Joseph A. Holmes, and Marius R. Campbell, to direct the construction and operation of the plant.

It will be observed that under the law authorizing this work all of the testing machinery and all of the coals to be tested had to be furnished to the Government free of charge. Under these conditions it was not possible to equip an ideal testing plant, and the assembling and construction of such equipment as could be obtained under these provisions entailed some annoying delays in the completion of the plant. In addition to this, the delivery of a considerable quantity of operating and conveying apparatus purchased from the Link Belt Machinery Company, of Chicago, was delayed by a strike in the works of that company. As a result of these combined influences the plant was not put in operation until the 1st of September.

Notwithstanding these delays, the committee feels that through the hearty and patriotic cooperation of a large number of manufacturers of apparatus and machinery it was able to collect and install, within a notably short time, a testing plant that was well suited for such pioneer work.

BUILDINGS.

The buildings for the housing and protection of the machinery and of the operators in charge, with the exception of the chemical laboratory, were built by contract and paid for out of the appropriation. These buildings (see fig. 1, p. 27) were:

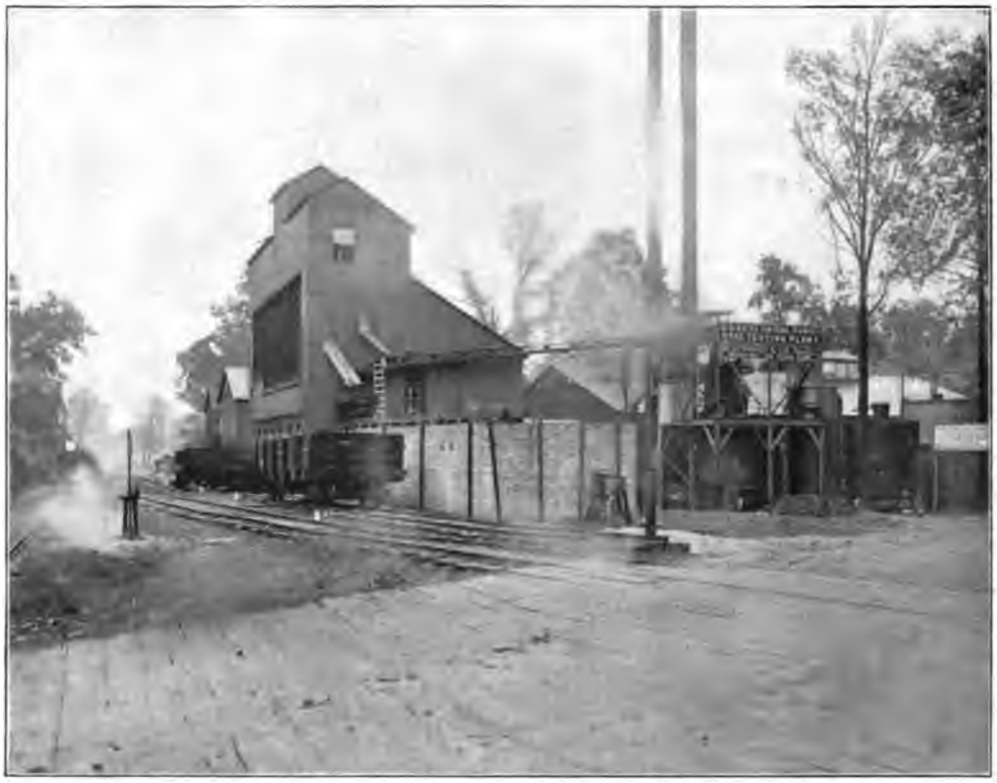
(1) A boiler and engine house, in which were installed 2 Heine safety boilers, 1 Frost boiler, 1 Allis Corliss steam engine, 1 Westinghouse gas engine, 1 Bullock generator, 1 Westinghouse generator, an electric switchboard, a gas-analyzing laboratory, and all the incidental apparatus pertaining to the operations of these portions of the plant. The contract price for the construction of this building was $2,700. It was built by the Barwick Construction Company, of St. Louis.

(2) A storage and washery building, in which were installed 5 storage bins of 35 tons capacity each, 2 coal washers, 1 revolving screen, 1 set of crushing rolls, 1 pulverizer, 1 Frost steam engine, 1 hopper scale, and the conveying machinery adapted for such a plant. This building, which had to be of extra strong material and construction, was completed at a contract cost of $4,550, the Settle-Price Construction Company, of St. Louis, being the contractor.

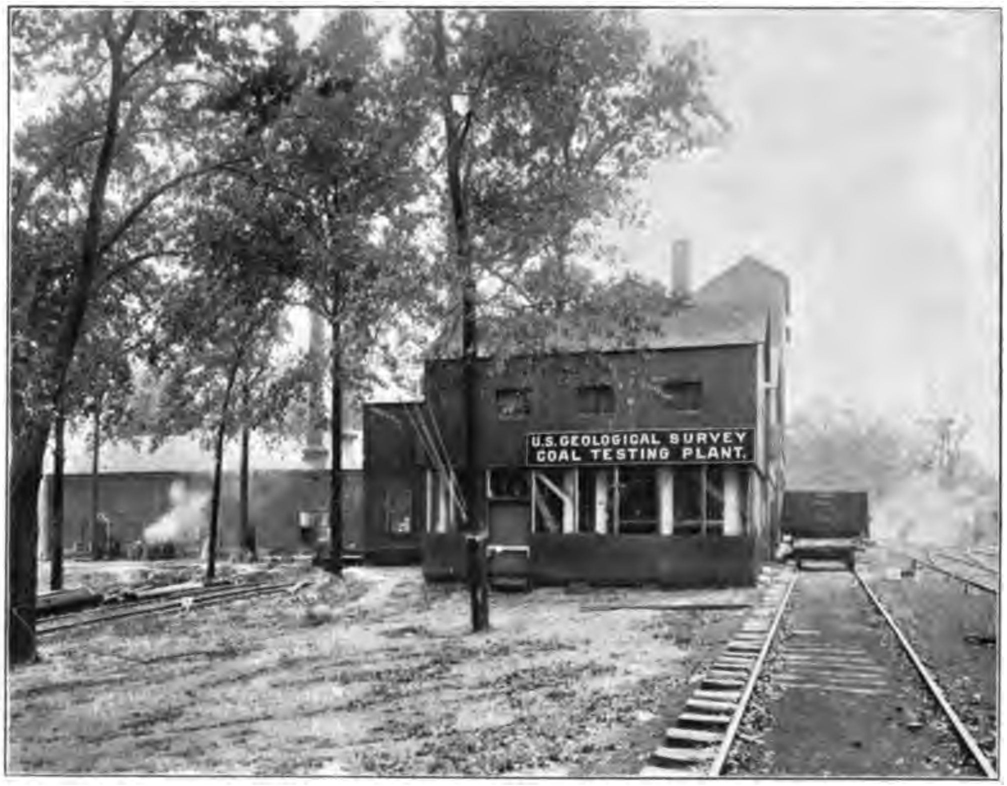
(3) Two buildings for briquetting machines and equipment, one built by the Baerveldt Construction Company, of St. Louis, for $1,050, and the other by the Barwick Construction Company, of St. Louis, for $693.

In the letting of all contracts, bids were obtained from at least five responsible bidders.

The chemical laboratory was installed in the Metal Pavilion, a short distance from the other buildings.



A. VIEW OF PLANT, LOOKING EAST.



B. VIEW OF PLANT, LOOKING WEST.

EQUIPMENT.

The plant, when put into operation in September, contained the following testing equipment, all of which had been contributed free of charge:

Two Heine water-tube boilers, 210 horsepower each, contributed by the Heine Safety Boiler Company, of New York and St. Louis.

One Allis Corliss engine, contributed by the Allis-Chalmers Company, of New York and Chicago. The Corliss engine was belt-connected to a Bullock electric generator contributed by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio.

One Frost fire-tube boiler of 100 horsepower and a 50-horsepower slide-valve engine, both contributed by the Frost Engine Company, of Galesburg, Ill.

One Taylor gas producer, with complete outfit for scrubbing and purifying gas, contributed by R. D. Wood & Co., of Philadelphia.

One Westinghouse gas engine, of 235 brake horsepower, furnished by the Westinghouse Machine Company, of Pittsburg, and operated by the gas made in the Taylor producer.

One Westinghouse electric generator, belt-connected to the gas engine, contributed by the Westinghouse Electric and Manufacturing Company, of Pittsburg.

Seven motors of different horsepower, required for the operation of the different portions of the plant, contributed by the Westinghouse Electric and Manufacturing Company.

One Bartlett direct-heat rotating drier for driving out the moisture from washed coals and lignites whose moisture contents were too high to permit successful briquetting, contributed by the C. O. Bartlett & Snow Company, of Cleveland, Ohio.

Two briquetting plants--one exhibited by William Johnson & Sons, of Leeds, England, and one by the American Compressed Fuel Company, of Chicago. In order that the briquetting machine of British manufacture should be installed in conformity with the law, the freight bill was paid by the Western Coal and Mining Company, of St. Louis.

A washing plant equipped with a New Century jig, contributed by the American Concentrator Company, of Joplin, Mo., and a modified Stewart jig, contributed by the Link Belt Machinery Company, of Chicago.

The fire brick and common brick used in the construction of the coke ovens were donated by the Laclede Fire Brick Manufacturing Company, of St. Louis.

The foregoing statement includes all that might properly be considered testing machinery, but the following additional incidental equipment and material were contributed by the firms mentioned:

One Williams crusher, by the Williams Patent Crusher and Pulverizer Company, of St. Louis.

A complete outfit of belt-conveying apparatus, contributed and installed by the Robins Conveying Belt Company, of New York.

Scales, by Fairbanks, Morse & Co., of New York and Chicago.

Smoke-preventing device, automatic steam jet, by H. H. Hughes, of St. Louis.

Thermometers and pressure gages, by the Hohmann & Maurer Manufacturing Company, of Rochester, N. Y.

Draft gages, by the Appliance Manufacturing Company, of Chicago.

Feed-water heater and pump, by the Stilwell-Bierce Smith-Vaile Company, of Cincinnati.

Le Chatelier pyrometers, by Charles Engelhard, of New York.

Engine indicators and attachments, by the Ashcroft Manufacturing Company, of New York, and the Crosby Steam Gage and Valve Company, of Chicago.

Metallic piston packing, by the Steel Mill Packing Company, of Detroit, Mich.

Burroughs adding machine, by the American Arithmometer Company, of St. Louis.

Insulated electric wire, by the American Steel and Wire Company, of Chicago.

Machine and engine oil for lubricating the machinery, and heavy and medium oil for binding material in the manufacture of briquettes from bituminous coals and lignites, by the Waters-Pierce Oil Company, of St. Louis.

Oil filter, by the Famous Filter Company, of St. Louis.

Gas meters, by the Pittsburg Meter Company, of Pittsburg.

Dumping car and bucket conveyors, by the Austin Manufacturing Company, of Chicago.

Centrifugal pump, by Henion & Hubbell, of Chicago.

Coal-tar pitch, by the Barrett Manufacturing Company, of New York and elsewhere, and the Chatfield Manufacturing Company, of Cincinnati.

Power crusher and automatic sampler for preparing samples for the chemical laboratory, by the F. W. Braun Company, of Los Angeles, Cal.

Cooking range, by the Buck Stove and Range Company, and a heating stove, by the Bridge & Beach Manufacturing Company, both of St. Louis, for the purpose of testing briquettes for domestic use.

Calculating machine, by the Keuffel & Esser Company, of New York.

The plans for the buildings and their arrangement (see fig. 1) were prepared by the Roberts & Shaefer Company, engineers, of Chicago. The construction work was done under the supervision of Mr. Bert. Fankboner, one of the engineers for the Roberts & Shaefer Company. Mr. Fankboner was accidentally killed by an electric locomotive early in October, just as the plant had been placed in successful operation and when he could have enjoyed the results of his hard and conscientious labor.

The boiler room was thoroughly equipped with standardized apparatus for weighing coal and water, for determining the force of the draft, for ascertaining the temperatures in the different parts of the furnace, and for analyzing the flue gases. The gas producer and gas engine were also provided with apparatus for ascertaining temperatures, for collecting samples of the gas as produced, and for determining the horsepower developed in the gas engine. The electrical horsepower developed by both the steam engine and the gas engine was ascertained by twenty-minute readings of voltmeters and ammeters, and the electrical horsepower developed per pound of fuel consumed by the two different methods was thus accurately determined and recorded.

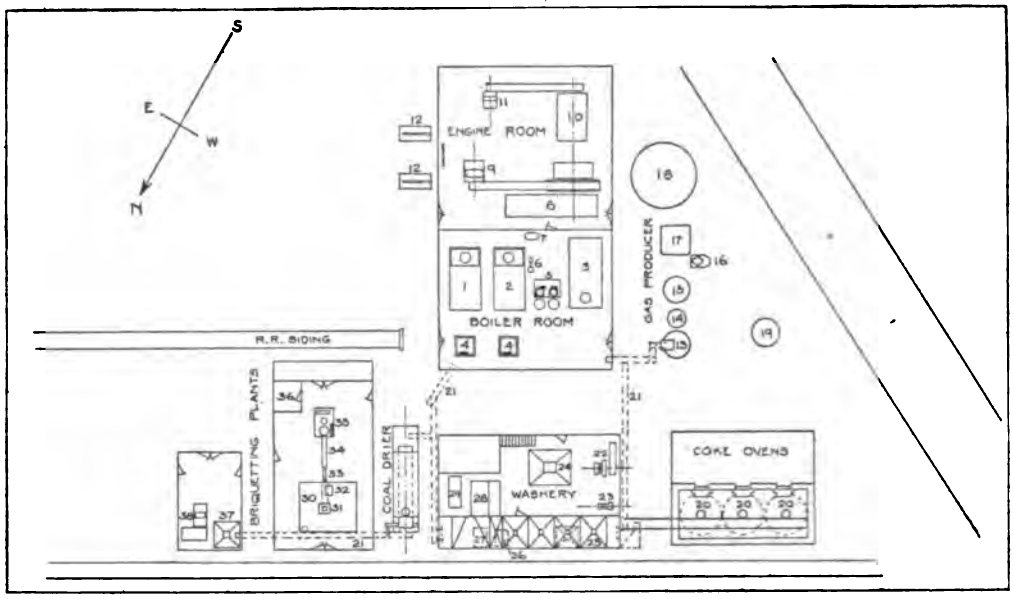


FIG. 1.—General plan of coal-testing plant.

1. Heine boiler, No. 1.
2. Heine boiler, No. 2.
3. Frost boiler.
4. Coal-weighing scales.
5. Water-weighing scales.
6. Feed pump.
7. Feed-water heater.
8. Allis-Chalmers Corliss engine.
9. Bullock D. C. generator.
10. Westinghouse gas engine.
11. Westinghouse D. C. generator.
12. Water rheostats.
13. R. D. Wood & Co. gas producer.
14. R. D. Wood & Co. economizer.
15. R. D. Wood & Co. scrubber.
16. R. D. Wood & Co. tar extractor.
17. R. D. Wood & Co. purifier.
18. R. D. Wood & Co. gas holder.
19. Forter gas producer.
20. Coke ovens.
21. Conveyors.
22. Steam engine.
23. Centrifugal pump.
24. Sludge tank.
25. Hoppers.
26. Roller crusher.
27. Williams mill.
28. Link-belt jig.
29. Century jig.
30. Mixer.
31. Hopper.
32. Pitch cracker.
33. Elevating fan.
34. Elevator.
35. Wm. Johnson & Sons briquetting machine.
36. Office.
37. Hopper and storage.
38. Chisholm, Boyd & White briquetting machine.

The chemical laboratory was equipped with every apparatus and chemical material necessary for making proximate and ultimate analyses and for determining the calorific value of the coal. The last was determined by a Mahler bomb calorimeter, and the observations were made in a room especially set aside for this purpose. Calorific values were also calculated from the ultimate analyses and, as shown by the report of the chemical laboratory, these calculations check very closely with the calorimeter determinations.

The railroad companies entering St. Louis or having coal resources along their lines have cooperated most heartily with the committee in charge of the work.

PERSONNEL.

The various portions of the plant were put under the direction of men thoroughly equipped in their special lines. The steam test division was under the direction of Prof. L. P. Breckenridge, of the University of Illinois, with Prof. D. T. Randall, of the same university, as chief assistant. The gas-producer tests were under the direction of Prof. Robert H. Fernald, of Washington University, St. Louis, assisted by Capt. John A. Laird, also of St. Louis. The operation of the gas producer was directed by Messrs. Charles W. Lummis and C. O. Nordenson, expert engineers, of R. D. Wood & Co., of Philadelphia. The gas-engine operations were looked after by Mr. J. G. Culbertson, an engineer of the Westinghouse Company. The washing operations were under the superintendence of Mr. John D. Wick, of Chicago, general foreman of the plant. The coking plant was in charge of Mr. Fred. W. Stammler, of Johnstown, Pa., assisted by Mr. B. B. Boyd, of Uniontown, Pa. The briquetting tests were directed by Dr. Joseph Hyde Pratt, of the University of North Carolina and the North Carolina Geological Survey, assisted by Mr. A. A. Steel, of Omaha, Nebr. The plans for the chemical laboratory, its equipment and operations, were under the direction of Prof. N. W. Lord, of the Ohio State University. His chief assistant at the coal-testing plant was Mr. E. E. Somermeier, who is also his chief assistant in his university work. The engine room was in charge of Mr. Otto Kinner, a mechanical engineer, of St. Louis, and the electrical apparatus was looked after by Mr. Jos. Underwood, also of St. Louis. Mr. Louis H. Legler, of Evansville, Ind., rendered valuable service as timekeeper and general assistant foreman of the plant.

FIELD WORK.

The field work was placed in charge of Mr. M. R. Campbell, one of the committee appointed by the Director of the Survey for the prosecution of these tests. He was assisted throughout the field season by Messrs. J. Shober Burrows and John W. Groves, and, for a short time, by Mr. Frank W. De Wolf. All of the coal shipped to the plant for testing, with the exception of a few carloads, was collected under the supervision of one of these Survey officials. This was done to avoid any possibility of the criticism that selected coals had been subjected to these tests.

SAMPLING.

When the coal was shipped the Survey representative sampled it at two working faces of the mine, and the samples so obtained were shipped to the chemical laboratory for analysis. When the car was unloaded at the testing plant, what is known as a "laboratory car sample," consisting of about 200 pounds of coal, was taken from every car and sent to the laboratory, where the coal was pulverized, quartered down, and analyzed. Again, as the coal was distributed to different portions of the plant for testing, other samples were taken in a regular and uniform manner and sent to the laboratory for analysis. Such a series of coal analyses has never before been made in this country.

REPORTS.

A preliminary report of the operations of the different portions of the plant, prepared by the experts in charge, has already been published. The detailed report, fully illustrated by photographs, graphic charts, etc., and giving the methods employed and results obtained in much greater detail, is given in the following pages.

RESULTS.

It will be necessary to test a larger number and greater variety of coals and lignites, and to repeat with greater care some of the tests already made, before a full discussion of the results of these investigations can be properly entered upon or their value fully appreciated. But the results already obtained from the preliminary investigations made during the time the plant was in operation are sufficient to indicate their far-reaching importance in the solution of the fuel and power problems upon which the varied industries of the country depend.

Among the results already clearly indicated by these preliminary tests the following may be stated as worthy of special consideration:

1. Probably the most important of the results accomplished has been the demonstration that bituminous coals and lignites can be used in the manufacture of producer gas, and that this gas may be consumed in internal-combustion engines for the development of power, with a fuel economy of over 50 per cent. The use of producer gas made from anthracite coal, from coke, or from charcoal for power purposes, and of producer gas from bituminous coal in steel works, etc., is no new story; but the demonstration of the possibility of utilizing bituminous coal and lignite in the gas engine is a decided advance in the economical combustion of coal for power. It has been shown by comparative tests (see p. 978)

that the power-producing efficiency of a number of bituminous coals, when converted into gas and used in the gas engine, is 2½ times what it is when used under boilers in the production of steam power. In other words, 1 ton of coal used in the gas-producer plant has developed, on a commercial scale, as much power as 2½ tons of the same coal used under Heine boilers with a simple Corliss engine. The results were measured by the amount of electrical horsepower per hour delivered at the switch board.

2. Of scarcely less importance are the results obtained in the use of lignite in the gas-producer plant. It has been shown that a gas of higher quality can be obtained from lignite than from high-grade bituminous coals, and that 1 ton of lignite used in a gas-producer plant will yield as much power as the best Pennsylvania or West Virginia bituminous coals used under boilers. It appears, in fact, that as coals decline in value when measured by their steam-raising power, they increase in value comparatively as a fuel for the gas producer. The brown lignites on which tests were made at the coal-testing plant were from North Dakota and Texas, and the unexpectedly high power-producing qualities developed by them in the gas producer and gas engine give promise of large future developments in these and other States in the far West, where extensive but almost untouched beds of lignite are known to exist.

3. The briquetting experiments have shown that the slack produced in the mining of many of the dry noncoking bituminous coals of the Middle West and of the semianthracite coals of the Southwest, which is now almost entirely wasted, may by briquetting be converted into a usable fuel on a commercial basis.

4. The work of the chemical laboratory, in connection with the sampling of the coal at the mines and at the testing plant, has not only set a standard for similar work in the future, but has developed the necessity for certain lines of investigation in the study of our mineral fuels.

5. The coking and washing tests have also given valuable results, which are well worth careful consideration.

ACKNOWLEDGMENTS.

For active cooperation in procuring coal to be tested, and its transportation to the testing plant, acknowledgments are due to many State geologists, and particularly to Prof. Frank A. Wilder, Director of the Iowa Geological Survey, who not only arranged for all samples of Iowa coal, but paid for transportation of at least one carload to St. Louis; to Dr. E. R. Buckley, State geologist of Missouri, who arranged for all samples of Missouri coals; and to Prof. Erasmus Haworth, State geologist of Kansas, for several samples of Kansas coal.

FIELD WORK.

By Marius R. Campbell.

COLLECTING COAL FOR TESTING PURPOSES.

INTRODUCTION.

The task of supplying the plant with coal for testing purposes was assigned to the writer. In this work he was assisted by Mr. J. Shober Burrows, Mr. John W. Groves, and Mr. Frank W. De Wolf. To Mr. Burrows was intrusted a large share of the work and responsibility, and the success attained is due largely to his intelligent and hearty cooperation and his unflagging interest in the work. Mr. Groves and Mr. De Wolf also rendered very valuable assistance. Mr. De Wolf was employed for only a short time, making a special trip to Wyoming and Colorado, but Mr. Groves was employed continuously during the time the plant was in operation.

In a circular letter sent out early in the season the coal operators of the United States were invited to participate in these tests, upon the conditions stated in the act of Congress under which the work was carried on, namely, that all material to be tested should be delivered at the testing plant free of cost to the Government. It was decided by the committee in charge that for practical tests of the character contemplated not less than one carload of coal should be accepted. In response to this invitation offers of coal were made from almost every coal-producing State in the Union. From these offers it was decided to accept such samples as best represented the State from which they were obtained, and also, as far as possible, the various fields or districts within the State. Owing, however, to the fact that the testing plant was not put in operation until late in the season, it was impossible to test all of the coal samples offered, and so a number of important coal fields and even States of large production were not represented.

It is a generally recognized fact that the value of tests upon fuel and similar materials depends largely upon the way in which the sample is obtained and what it represents. In the present work the committee in charge decided to give this feature special attention and in every case possible to superintend the collection of the samples, so as to be in a position to guarantee that the coal tested fairly represented the commercial product from the mine, so far, at least, as it is possible for one carload to represent the average output.

METHODS OF SAMPLING.

CAR SAMPLING.

In actual operation the sampling was done as follows:

After arrangements had been made for the coal and its transportation was assured, a representative of the testing plant visited the mine for the purpose of procuring a sample. He first entered the mine and carefully studied the character of the coal as shown in the bed before it was mined and the method of mining and of cleaning the coal as it was loaded on cars in the mine. After becoming familiar with the underground conditions, he visited the tipple and observed the manner of handling the coal for market, getting information regarding the arrangement of the screens, the grades of coal produced, the method of utilizing slack coal, washing, coking, etc. When this was accomplished the inspector supervised the loading of a car for testing purposes, selecting run of mine, lump, or nut coal, as seemed to him most nearly representative of the general output of the mine, or in particular cases selecting certain grades for special tests. The principal object in closely supervising the work was to procure representative coal; but how could such coal be procured? In order that a car shall contain average coal it must be loaded with coal from all parts of the mine. This could be done only by setting aside cars from different rooms until coal from all rooms had been obtained. This, however, is impracticable, as it would require a great many mine cars and more trackage than almost any mine possesses.

In the course of regular work coal comes from all parts of the mine in which work is carried on, therefore, in a mine of small or medium capacity a car loaded in the ordinary manner is likely to contain coal from all parts, and therefore representative coal. This was found to be the only practicable plan, and all coal was loaded as it came from the mine. The loading of the car was carefully watched so as to prevent undue picking or any irregularity that would tend to make the test sample better or worse than the average output.

In certain cases where a number of cars were in the yard, already loaded with what was regarded as representative coal, one of these cars was selected at random and shipped to the testing plant.

In case the car sample consisted of lignite or soft bituminous coal, such as probably would be affected by weathering in transit, it was loaded in a box car, but the great majority of samples were shipped in ordinary open coal cars without any protection from the weather. Most of this coal was shipped during the months of August, September, October, and November, and these months were unusually dry in the vicinity of St. Louis. For this reason it seems probable that the coal in transit was subjected to little wetting by rain or snow, and that the principal change caused by weather was due to general atmospheric conditions which probably affected not only the coal in open cars but that shipped in box cars also.

MINE SAMPLING.

As an additional check on the quality of the coal, and especially for the determination of its moisture content in its native condition, two samples were taken in each mine for chemical analysis. These were handled as follows: After a general inspection of the mine to determine the variations of the coal in thickness and in quality, two points were selected in opposite or widely separated parts of the mine, and after the face of the coal was cleaned of any weathered coal or powder smoke, a cut was made across the face of the coal from roof to floor, including all of the benches of coal mined and such impurities as were not removed in ordinary work. This cut was about 3 inches wide and 1 inch deep. The coal obtained from it, amounting to 25 or 30 pounds, was caught upon an oilcloth blanket spread upon the floor of the mine, so as to protect the sample from water and from admixture of shale and clay fragments that usually abound in such places.

The coal composing the sample was then pulverized and quartered down according to the generally accepted rules for preparing samples until a quart sample was obtained, the particles of coal being reduced to a size not much greater than one-half inch in diameter. The sample was placed in an air-tight galvanized iron can having a screw top, and the can was hermetically sealed by screwing the top down tight and covering the joint with tire tape. The can containing the sample was then mailed to the testing plant, and in almost all cases it reached its destination two or three days after the date of sampling in the mine. When the can reached the chemical laboratory the sample was at once transferred to a glass jar, in which it was sealed until the time arrived for making a chemical analysis.

UNINSPECTED CAR SAMPLES.

In a few cases carload samples were shipped to the testing plant without the personal supervision of a representative of the Government. In one case this was the result of a misunderstanding; in others the samples consisted of slack coal for special tests and their selection did not require personal supervision; while in others samples were sent under such conditions that supervision was impossible. In most cases information was furnished by the party sending the sample regarding the conditions under which it was secured, but in some cases no data were supplied, and the samples sent have therefore little value. Owing to the peculiar conditions under which these samples were sent, they were accepted, but the committee in charge does not care to hold itself responsible for the character of the coal thus sent. Tests have been made upon them, and the results are given for what they are worth.

DESCRIPTIONS OF SAMPLES.

In describing the coal sent to the testing plant, the samples from each State will be grouped and the States will be treated in alphabetical order. Figures denoting coal production are taken from the report on the production in 1904 by Mr. Edward W. Parker, statistician of the United States Geological Survey.

ALABAMA.

Alabama is one of the great coal-producing States of the Union. In 1904 it produced 11,262,046 short tons of coal, exceeded only by Pennsylvania, Illinois, West Virginia, and Ohio. As shown on the map accompanying this report (Pl. I, in pocket), the coal-bearing rocks of the State are divided into several fields, among which the Warrior basin is the most important, both in area and production. All of the coal sent to the testing plant from this State came from Walker County, which is located in the central part of the Warrior basin. The general location of the mines from which the samples were obtained is shown on the map. This county is second in coal production in the State, yielding 2,583,473 short tons of coal in 1904.

The Warrior basin lies northwest of a long anticlinal fold, on which is located the city of Birmingham. It is a basin in which there are several minor undulations, but in a general way the rocks dip lightly to the center from the north and northwest and steeply from the southeast side. The basin deepens gradually to the southwest, and in the vicinity of Tuscaloosa passes beneath the cover of Cretaceous rocks. Little is known regarding its extent in this direction.

About 23 coal beds that locally are of workable thickness have been recognized in this basin. They have been grouped in ascending order as follows: Black Creek, Horse Creek (Mary Lee), Pratt, Gwin, and Brookwood groups, each of which contains from two to eight seams of coal. The most important groups, as regards geographic extent and quality of coal, are the Horse Creek (Mary Lee) and Pratt. The coal beds of these two groups are extensively mined along the southeast and north sides of the basin.

The Horse Creek (Mary Lee) group of coals is supposed to consist of five principal seams named, in ascending order, Ream, Jagger, Blue Creek, Mary Lee, and Newcastle. According to Mr. Henry McCalley[a] the Jagger coal bed ranges in thickness from 0 to 15 feet, but in its thicker sections it contains many shale and clay partings. Alabama No. 2, or the car of coal obtained at Carbon Hill, Walker County, came from this bed, sections of which are given in the description of that sample on page 38.

The Mary Lee coal bed, according to McCalley,[b] ranges in thickness from 8 inches to 8 feet 2 inches. Alabama No. 1, or the car of coal obtained at Horse Creek, Walker County, came from this bed, and sections of the coal as it occurs in the type vicinity of Horse Creek are given below.

ALABAMA No. 1.

Operator.—Ivy Coal and Iron Company, Birmingham, Ala.

Mine.—Mine No. 8, 1½ miles west of Horse Creek, Walker County, Ala., on the St. Louis and San Francisco Railway (Frisco System).

Sampler.—Marius R. Campbell.

Coal bed.—This bed is locally known as the Horse Creek coal. Its thickness and character in the mine were determined by three carefully measured sections, two of which are shown in fig. 2. Section A was measured in first left entry off third right entry, about 1,450 feet from the mouth of the mine. Section B was measured in room 24 off second left entry, 1,250 feet from the mouth of the mine. Section C, below, was measured in main entry of mine No. 10, about 1,300 feet from the mouth of the mine. The sections are as follows:

Sections of coal bed in mines of the Ivy Coal and Iron Company, Horse Creek, Ala.

Section A.			Section B.			Section C.		
	Ft.	*in.*		*Ft.*	*in.*		*Ft.*	*in.*
Coal	2	8	Coal	2	10	Coal	2	8
Shale	0	1	Shale	0	½	Bone	0	1
Coal	0	4¾	Coal	0	5	Coal	0	6
Shale	0	1¼	Shale	0	¼	Bone	0	½
Coal	0	2	Coal	0	2½	Coal	0	¾
Shale	0	5	Shale	0	5½	Shale	0	5
Coal	1	10	Coal	1	5	Coal	3	6
Bone	0	1¼	Bone	0	1	Bone	0	1
Coal	1	0	Coal	2	4½	Coal	1	1
Bony coal	0	1						
Coal	1	2						
Total	8	¼	Total	7	10¼	Total	8	5¼

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[a] McCalley, Henry, Report on the Warrior Coal Basin: Geological Survey of Alabama, 1900.

[b] Op. cit.

Samples for chemical analysis.—Two samples were collected for chemical analysis.

Sample A was obtained at the point where section A was measured, by making a cut from roof to floor of the coal, excluding the partings and bony coal. The sample thus obtained weighed about 25 pounds, and was pulverized and quartered down until a quart sample was obtained. This was sealed in a galvanized-iron can and mailed directly to the chemical laboratory.

Sample B was obtained in room 24, at the point where section B was measured. A cut was made across the face of the coal from roof to floor, including all parts of the bed usually mined, but excluding the partings noted in the section. This sample weighed from 25 to 30 pounds. It was pulverized and quartered down until a quart sample was obtained, which was sealed as noted above and mailed to the chemical laboratory of the testing plant.

Character of car sample.—About 12 tons of "fancy lump" coal had been loaded on the car before the mine was visited by the inspector. Although this was not regarded as representative coal it was accepted, as no other car was available, but the screens were changed at once so as to load all coal passing over a 1-inch perforated screen. Much of the coal was wet as it came from the mine, and consequently the screen worked imperfectly, allowing much of the slack coal to pass into the car. This equalized the character of the coal, so that the average was probably about the same as dry coal screened over a 1-inch perforated screen.

Until recently there has been no effort to hand pick the coal as it was loaded, but now the tipple at mine No. 8 is equipped with a belt conveyor at which two men are stationed to pick the bits of shale and bony coal as the cars are loaded. In loading the sample car five pickers were employed, but owing to the wet condition of the coal picking was probably no more thoroughly done than in ordinary cases. The coal was shipped September 9 in an ordinary gondola car, and it was received at the testing plant September 27, 1904.

Equipment.—At present this company is operating 6 mines in this vicinity and preparing to open up several new ones. Most of the coal is consumed in the Birmingham district, but the Frisco and Southern railroads draw on this field to some extent for engine coal. The slack coal from mine No. 10, which is adjacent to mine No. 8, is washed in a Jeffrey washer and sold to the Woodward Iron Company for coking purposes. When used alone it cokes with difficulty, but when mixed with slack coal from the Pratt seam it makes a merchantable coke.

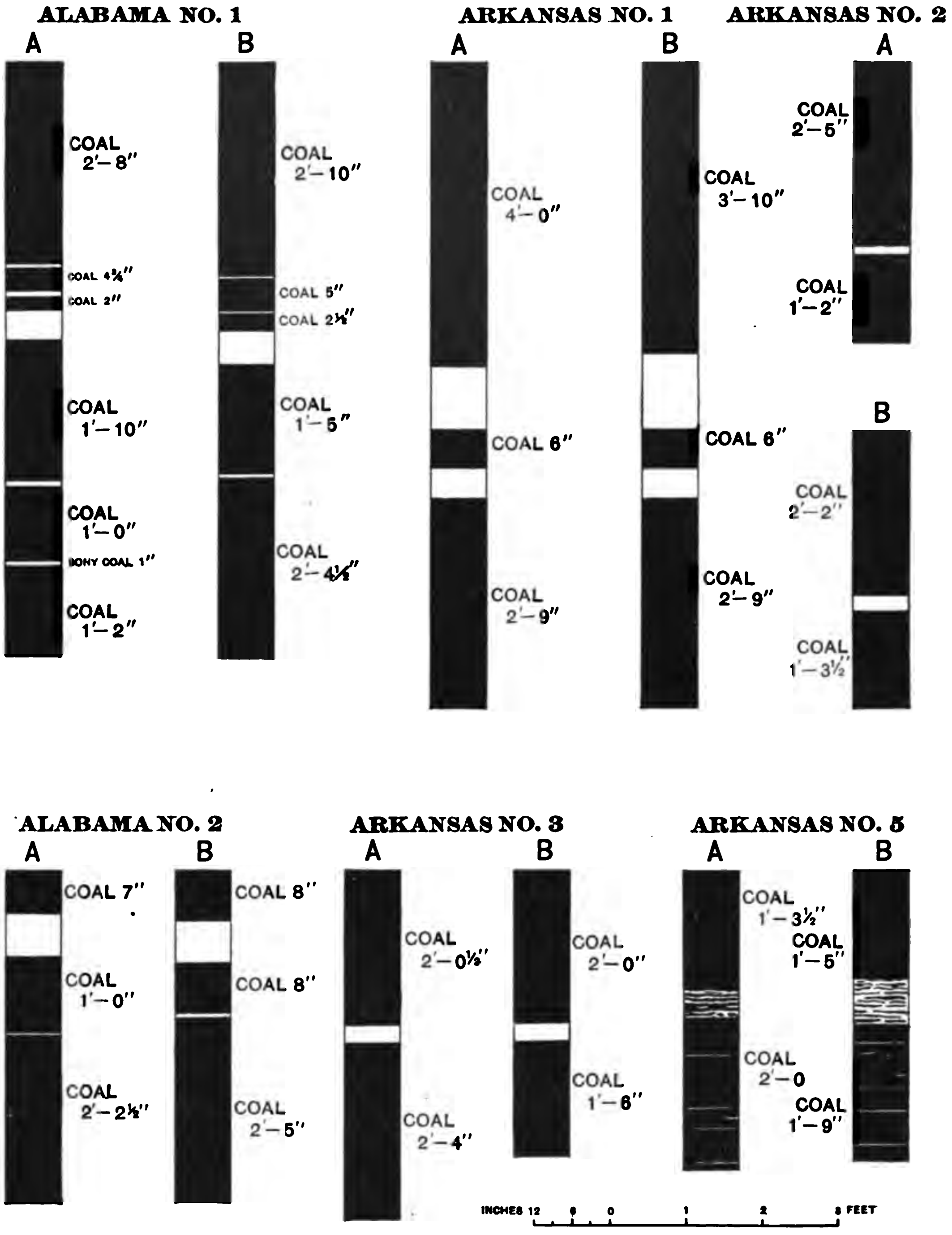

FIG. 2.—Sections of Alabama and Arkansas coal beds.

NOTE.—The thickness of the lowest bench in section A, Arkansas No. 1, should be 1 foot 10 inches.

Mine No. 8 is a slope mine, although the coal shows in outcrop above drainage level. The slope was driven so as to secure sufficient height for a tipple without having to cross the valley. The slope is about 300 feet long and the grade is about 10 per cent.

The roof of this mine is excellent, consisting of a strong sandy shale which requires almost no timbering, although all the rooms are 20 feet wide.

Mining is done on the bench below the principal shale parting shown in the sections. When this bench is removed, the upper benches are shot down and the lower bench shot up. The principal parting is supposed to be thrown out, but no effort is made in the mine to get rid of the other partings.

ALABAMA No. 2.

Operator.—Galloway Coal Company, Memphis, Tenn.

Mine.—Chickasaw No. 5, about three-fourths of a mile northwest of Carbon Hill, Walker County, Ala., on the Frisco Railroad.

Sampler.—Marius R. Campbell.

Coal bed.—This coal is locally known as the Jagger coal bed. It lies nearly horizontal and seems to occur in swamps or local developments of thick coal. The coal was carefully measured at two rather widely separated points in mine No. 5, and the sections are shown graphically on fig 2. Section A was measured in the third west entry off the main north entry at a point about 2,000 feet from foot of the slope, and section B was measured in the fourth east entry at a distance of about 1,200 feet from the foot of the slope. The sections are as follows:

Sections of coal bed in mine No. 5, Galloway Coal Company, Carbon Hill, Ala.

Section A.			Section B.		
	Ft.	in.		Ft.	in.
Coal	0	7	Coal	0	8
Shale	0	7	Shale	0	7½
Coal	1	0	Coal	0	8
Dirty coal	0	1	Bone	0	1
Coal	2	2½	Coal	2	5
Total	4	5½	Total	4	5½

Samples for chemical analysis.—Two samples were collected in mine No. 5 for chemical analysis. Sample A was taken at the point where section A was measured. The coal for this sample was obtained by making a cut across the face of the coal from roof to floor, throwing out all the partings noted in this section. From 25 to 30 pounds of coal were thus obtained. This was pulverized and quartered down to a quart sample. It was sealed in the ordinary way and mailed to the chemical laboratory of the testing plant.

Sample B was taken at the point where section B was measured in the fourth east entry. The coal for this sample was obtained by making a cut from roof to floor exclusive of the partings noted in section B. This was pulverized and quartered down at the mine to the customary quart sample, which was mailed at once to the testing plant.

Character of car sample.—The product of this mine is graded into "fancy lump" and "engine coal." The "fancy lump" is such as passes over an 8-inch bar screen; it is generally sold for domestic use. "Engine coal" is that which passes through an 8-inch bar screen and over a three-fourths-inch perforated screen. The slack passing through the latter screen is washed and the resulting "pea coal" is returned to the cars containing "engine coal." If the lump coal came from any particular part of the bed, the "engine coal" would not be strictly representative, but the lump coal comes from all parts of the bed and consequently its absence does not affect the quality or the representative character of the engine coal. The same is true to a certain extent of the slack, although the latter is more likely to be made up of impurities from the partings than of good coal.

The coal was shipped in an ordinary gondola car on September 9 and was received at the testing plant September 22, 1904.

Equipment.—The Galloway Coal Company operates three mines in this district, known as Chickasaw Nos. 4, 5, and 6. Mine No. 5, from which the car sample was obtained, is a slope mine about 27 feet below the surface. The coal is raised by a belt conveyor and about 50 per cent of the coal is mined by compressed-air machines. Most of the mines of this company are equipped with washeries, but owing to poor water supply they are greatly hampered in dry weather.

Most of the coal from this mine is used by the Frisco System for engine coal; the remainder finds a ready market in the Birmingham district for domestic and factory use.

SPECIAL SAMPLES OF ALABAMA COALS.

The following table gives data concerning the special samples of Alabama coals taken for chemical analysis:

Special samples of Alabama coal, taken for chemical analysis.

Laboratory number.	Coal bed.	Mine.	Town.	County.	Owner.	Sampler.	Date.	Total thickness of bed.		Page of analysis.
								Ft.	*in.*	
1145	Blue Creek.	Adger......	Adger......	Jefferson...	Tennessee Coal, Iron and R. R. Co.	Chas. Butts.....	Sept. 27	10	10	267
1146	.....do......	Johns.......	Johns.......	.....do......	.....do..........	E. F. Burchard..	Sept. 26	7	6¼	267
1148	.....do......	....do.......	.....do......	.....do......	.....do..........	.....do..........	...do....	7	6¼	267
1149	.....do......	Adger......	Adger......	.....do......	.....do..........	Chas. Butts.....	Sept. 27	8	0	267
1164	Brookwood.	Central.....	Kellerman.	Tuscaloosa.	Central Coal and Iron Co.	.....do..........	Sept. 30	7	2¼	267
1186	Milldale....	Slope No. 7..	Brookwood.	.....do......	Consolidated Coal and Iron Co.	.....do..........	Oct. 1	2	2	267
1187	Carter......	Drift No. 10.	.....do......	.....do......	.....do..........	.....do..........	....	3	0	268
1158	Blue Creek.	Belle Sumpter.	Belle Sumpter.	Jefferson...	Tennessee Coal, Iron and R. R. Co.	E. S. Pinckard..	....	....		268
1189	.....do......	.....do......	.....do......	.....do......	.....do..........	.....do..........	....	....		268
1210	Brookwood.	Searles.....	Searles.....	Tuscaloosa.	Consolidated Coal and Iron Co.	E. F. Burchard..	....	....		268
1593	.....do......	Tidewater..	Tidewater..	.....do......	Warrior Coal Co.	Chas. Butts.....	Nov. 12	....		268

RESULT OF TESTS.

The analyses given on pages 196–197 of the two coal samples from Alabama show that they are similar in composition and that the results obtained with one could probably be duplicated with the other, except in the manufacture of coke. In this respect the Horse Creek coal (Alabama No. 1) is superior to Carbon Hill coal (Alabama No. 2), at least when ordinary beehive ovens are used. It is possible that with improved retort ovens better results could be obtained with the Carbon Hill coal, but no data are yet available to determine this point.

The steam-producing quality of the two coals is very similar, and it is probable that they would yield equally good results in the gas producer and gas engine. On account of lack of time a producer-gas test was made only on Alabama No. 2. The results given on pages 344 and 1029 show that 4.08 pounds of dry coal were consumed under the steam boiler in the production of one electrical horsepower hour and that in the producer plant the same power was produced by the consumption of 1.64 pounds of dry coal, a gain in efficiency over the steam plant of 149 per cent.

The average gain in efficiency in tests of 14 different coals is 153 per cent. From this it is apparent that the gain in the use of Alabama coal in this way is near the average and 107 per cent better than the best West Virginia coal under the steam boiler.

There seems to be no question that about the same results could be obtained with Alabama No. 1 coal.

ARKANSAS.

This State includes two areas of coal-bearing rocks—one of Carboniferous age, situated in the western-central part of the State, along Arkansas River, and one of Tertiary age in the southern part of the State, extending at least from Texarkana to Arkansas River. The former contains high-grade bituminous and semibituminous coal, and from this field in 1904 there were produced 2,009,451 short tons of coal. The latter field contains nothing but brown lignite, and up to the present time there has been little or no demand for this class of fuel and no development has taken place.

The Carboniferous coal field is a wide, irregular, unsymmetrical trough of coal-bearing rocks, which enters the State from the west in the vicinity of Fort Smith and extends eastward to Dardanelle on Arkansas River.

On the southern margin of the field the folding is more pronounced and the result is a number of basins or troughs separated by underlying and barren rocks. On the north the basin is wide and shallow, and its outline is much more regular than on the southern side.

In this field there are two principal horizons that carry workable coal seams. The upper horizon is present in the western end of the field, in the vicinity of Fort Smith, and the bed is generally known as the Huntington or Jenny Lind coal. The lower horizon is coal bearing only in the eastern part of the field and the principal bed is generally known as the Spadra coal.

The Huntington coal bed is extensively mined at Hartford, Huntington, Midland City, Bonanza, and Jenny Lind, which are located south and southeast of Fort Smith. Car samples for testing were procured from Huntington, Bonanza, and Jenny Lind. The mine at Huntington is in the southernmost basin. This basin is of considerable geographic extent, and the coal is mined at Huntington, Hartford, and a number of other places along the outcrop of the coal. The mines at Bonanza and Jenny Lind are in a distinct basin, being separated from the Huntington basin by the "Backbone" ridge, a sharp anticline composed of lower rocks. Some doubt exists regarding the equivalence of the Huntington and Jenny Lind coal beds, but many regard them as exactly equivalent and they will be so considered here.

The Spadra coal bed occurs in lower rocks than the Huntington coal. It is extensively mined in the region about Denning in Franklin and Johnson counties, and to some extent farther east in the vicinity of Spadra. Car samples for testing purposes were received from the vicinity of Denning. The general location of the mines furnishing samples for testing is shown on the large map in the pocket of this volume.

ARKANSAS No. 1.

Operator.—Central Coal and Coke Company, Kansas City, Mo.

Mine.—Mine No. 3, 1 mile west of Huntington, Sebastian County, Ark., on the Frisco Railroad.

Samplers.—Marius R. Campbell and John W. Groves.

Coal bed.—This coal is locally known as the Huntington coal. It lies in a synclinal basin, the axis of which extends from Huntington westward, beneath Sugar Loaf Mountain. The pitch of the axis to the west is about 120 feet per mile. The field averages about 2 miles in width, and covers an area of about 14 square miles.

The thickness and character of the bed in the Huntington region is shown in fig. 2 by two sections obtained in different localities in mine No. 3. Section A was measured in the fourth east entry on the north side and section B was measured in the fourth east entry on the south side. The sections are as follows:

Sections of coal bed in mine No. 3, Central Coal and Coke Company, Huntington, Ark.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	4	0	Coal	3	10
Shale and coal	0	10	Shale and coal	1	0
Coal	0	6	Coal	0	6
Shale, black	0	5	Shale, black	0	5
Coal	1	10	Coal	2	9
Total	7	7	Total	8	6

Samples for chemical analysis.—Two samples for chemical analysis were collected in mine No. 3. Sample A was collected at the point where section A was measured. The coal for this sample was obtained by making a cut across the face of the bed from roof to floor, throwing out the partings noted in the section given above. The sample was pulverized and quartered down to quart size in the usual way and mailed to the testing plant.

Sample B was taken at the point where section B was measured. The coal for this sample was obtained by making a cut from roof to floor across a working face of the coal, exclusive of the partings shown in section B. This was pulverized and quartered down at the mine in the usual way, and a quart sample was sealed in a galvanized-iron can and sent to the chemical laboratory of the testing plant.

Character of car sample.—The coal from this mine is largely used by the Frisco Railroad for engine coal. For this use it is screened over bar screens having openings of 1⅛ inches in width. That which passes through is generally sold to the Kansas City packing houses, but at some seasons of the year there is little or no demand for it, and then it is dumped beside the tracks, a total loss. Engine coal consists of lump and nut coal. Since this is the general grade of coal marketed at this mine it was selected for testing purposes. When the inspector visited the mine a number of gondola cars were loaded ready for the market, and from these one was selected at random for shipment to the testing plant. This car contained about 44 short tons of engine coal. It was shipped from the mine on September 1 and was received at the testing plant on September 15, 1904.

Equipment.—Mine No. 3, from which this sample was obtained, is located nearly on the axis of the synclinal basin, and the coal bed is reached by a shaft 110 feet deep.

Mining is done by the room-and-pillar system, and since the shaft is nearly on the axis of the syncline all the coal on the two sides and toward the point of the basin can be brought to the foot of the shaft by mules at slight expense. The coal is soft and it is mined entirely by hand, being shot from the solid. The roof is generally good and little timbering is required in the mine. This company has in operation in this district three mines, known as Nos. 1, 2, and 3. The capacity of mine No. 3 is about 800 tons a day.

ARKANSAS NO. 2.

Operator.—Central Coal and Coke Company, Kansas City, Mo.

Mine.—Mine No. 12, about 1 mile east of Bonanza, Sebastian County, Ark., on the Frisco Railroad.

Samplers.—Marius R. Campbell and John W. Groves.

Coal bed.—This coal is probably best known as the Jenny Lind coal, from a mine which has been operated for a long time 2 or 3 miles east of Bonanza. This coal bed lies in a separate synclinal basin from the Huntington coal, the two basins being separated by a sharp anticlinal ridge trending east-west and crossed by the Frisco Railroad just south of Hackett.

No direct connection can be made between the Bonanza and the Huntington coal beds, but in all probability they are the same or at about the same horizon. The section and thickness are, however, very different, and for that reason they are regarded by many as different beds.

The structure of the Bonanza bed is shown in fig. 2 (p. 37) by two sections which were obtained at widely separated localities in mine No. 12. Section A was measured in the fourth east entry and section B was measured in the seventh west entry. The sections are as follows:

Section of coal bed in mine No. 12, Central Coal and Coke Company, Bonanza, Ark.

Section A.	Ft.	in.	Section B.	Ft.	in.
Shale roof:			Shale roof:		
Coal	2	5	Coal	2	2
Shale	0	1½	Shale	0	2½
Coal	1	2	Coal	1	3½
Total	3	8½	Total	3	8

Samples for chemical analysis.—Two samples were collected in this mine for chemical analysis.

Sample A was taken at the place where section A was measured. The coal from this sample was obtained by making a cut from roof to floor of the bed exclusive of the black-shale parting. This was reduced as usual to a quart sample, which was sealed in a galvanized-iron can and mailed to the chemical laboratory.

Sample B was taken from the place where section B was measured. The coal for this sample was obtained by making a cut from roof to floor on a working face of the coal exclusive of the black-shale parting. This was reduced to a quart sample, which was sealed and mailed directly to the chemical laboratory.

Character of the car sample.—About 55 per cent of the coal from this mine is sold to railroads for engine use, most of it going to the Frisco and Kansas City Southern railways. About 15 per cent goes to manufactories, and 30 per cent, or the slack, goes to the Kansas City packing houses. Although the slack naturally contains more impurities than the lump coal, it also contains much of the best part of the bed. This is generally true of Arkansas coals, and it is due to the friable nature of the coal. The best coal of the bed breaks down mechanically and passes through the screen with the slack coal.

Although run-of-mine coal is generally desired for testing purposes, the facts noted above made it less imperative to obtain that particular grade, and since it was almost impossible to load run-of-mine coal, lump and nut were accepted. Until recently little or no attempt has been made to pick the coal as it was loaded, but now this is fairly well done, with the result that the quality of the coal has greatly improved.

The coal for testing was loaded in a gondola car and consisted of all coal passing over a bar screen with 1½-inch openings. During the loading the coal was picked by four pickers, the number usually employed in such work. The car was shipped September 2 and was received at the testing plant September 15, 1904.

Equipment.—Mine No. 12 is located on the southern outcrop of the coal, which lies in a broad, flat synclinal trough reaching from Bonanza on the south nearly to Fort Smith on the north and extending in an east-west direction far beyond the limits of Sebastian County.

The mine is opened on the outcrop of the coal and it is carried downward as a slope toward the center of the basin to the north. The slope has a grade of about 6 feet in 100 feet. It has been driven in about 3,000 feet and the haul is so long that a shaft is being opened farther north and at a lower point in the basin from which all of the coal adjacent to mine No. 12 will be taken. The present capacity of this mine is about 500 tons daily.

The mine has connection with both the Frisco system and the Kansas City Southern Railway. The coal is all mined by hand and it is hauled to the main gangway by mules.

ARKANSAS NO. 3.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 18, located in sec. 36, T. 7 N., R. 32 W., at Jenny Lind, Sebastian County, Ark., on the Missouri Pacific Railway.

Sampler.—John W. Groves.

Coal bed.—This bed is locally known as the Jenny Lind coal, but it is probably the same as the coal mined in the next basin to the south and known as the Huntington coal. The Jenny Lind mines are located on the south limb of a wide, shallow basin which probably extends from this place to the vicinity of Fort Smith, but near the river the coal is obscured by the wide bottom lands, and appears to die out, or at least little is known regarding it.

The thickness and character of the bed in mine No. 18 are shown by four carefully measured sections, two of which, sections A and B, are represented in fig. 2. Section A was measured in the main east slope, section B was measured in the main west slope, and sections C and D were measured in other widely separated localities in the mine.

Sections of coal bed in mine No. 18, Western Coal and Mining Company, Jenny Lind, Ark.

Section A.	Ft.	in.	Section B.	Ft.	in.	Section C.	Ft.	in.	Section D.	Ft.	in.
Coal	2	1	Coal	2	0	Coal	1	2	Coal	2	2
Shale	0	3½	Shale	0	3	Shale	0	3	Shale	0	2½
Coal	2	4	Coal	1	6	Coal	2	10	Coal	1	4
Total	4	8	Total	3	9	Total	4	3	Total	3	8½

Samples for chemical analysis.—Two samples were collected in this mine for chemical analysis, as follows:

Sample A was from the main east slope at the point where section A was measured. The coal for the sample was obtained by making a vertical cut across the face of the coal bed including everything except the shale bed 3½ inches thick, shown in section A, above. The coal so obtained was crushed and quartered down to about 1 quart, which was sealed in a galvanized-iron can and mailed to the chemical laboratory of the testing plant.

Sample B was obtained in the main west slope at the place where section B was measured. It was obtained by channeling the coal from roof to floor, throwing out in the process all of the material of the main shale parting 3 inches thick. This sample was pulverized and quartered down to quart size, and this was mailed to the chemical laboratory in a sealed galvanized-iron can.

Character of car sample.—The principal use of the coal from this mine is for steam purposes. At the present time more than half the output is used by the Missouri Pacific Railway for locomotive fuel. Like most of the Arkansas coals there is a large percentage of slack, and the better utilization of this waste product was the principal incentive for furnishing the coal for testing purposes.

The car contained about 40 short tons of coal. Of this one-half, or about 20 tons, [illegible] passed over a 1½-inch bar screen, and the other half slack or that which passed through the screen mentioned above.

The coal was loaded in an ordinary gondola car, which was shipped from [illegible] and reached the testing plant October 7, 1904.

Mine No. 18, from which this sample was obtained, is located [illegible] outcrop of the coal, and the bed is reached by [illegible] dips slightly to the north or toward the center [illegible] principal workings are in the opposite direction. [illegible] room and pillar system is used. Most of the [illegible] coal is shot off the solid. The coal is overlain by a hard shale which makes a strong, durable roof. The clay immediately underlying the coal is soft, but at a depth of a few inches it is firm and unyielding.

The coal is somewhat affected by "horsebacks," etc. In places the thickness of the bed is only slightly reduced by the "horsebacks," but occasionally the coal is entirely replaced by shale, which makes mining expensive. Since the workings are extended up the dip the coal is easily delivered to the foot of the shaft by mules, and the water accumulates in a sump at the same place.

The daily capacity of the mine is about 550 tons. The company operates another mine (No. 17) in this vicinity, and contemplates the development of new mines in the field.

ARKANSAS No. 4.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mines.—This sample came from four mines located in the vicinity of Denning, Franklin County, Ark., on the Missouri Pacific Railway.

Sampler.—Shipped by operator.

Coal bed.—The mines of this district are generally regarded as working on the Spadra coal. The thickness of the bed and the arrangement of its partings are shown in sections measured in mine No. 4 (see fig. 2, Arkansas No. 5). These are described on page 48.

Character of car sample.—This sample was sent for briquetting tests, and it consisted of slack coal taken from a pile which had accumulated in the yards of the Union Fuel Company, St. Louis.

ARKANSAS No. 5.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 4, located 1½ miles west of Coal Hill, Johnson County, Ark., on the Missouri Pacific Railway.

Sampler.—John W. Groves.

Coal bed.—This coal bed belongs to the lower division of the coal-bearing rocks of the Arkansas field. Locally it is known as the Denning seam, but probably it corresponds with the Spadra bed, which is typically developed a little farther east.

The thickness of the bed and the arrangement of the various bands of impurities were determined by making four detailed sections in various parts of the mine. There is so little variation in the coal that the two sections shown in fig. 2 may be taken as fairly representative of the coal bed as it appears in this mine. Section A was measured in room 45 off first east entry on slope and section B was measured in room 38 off second east entry on plane. The sections are as follows:

Sections of coal bed in mine No. 4, Western Coal and Mining Company, Coal Hill, Ark.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	1	3½	Coal	1	5
Shale mixed with coal	0	5½	Shale mixed with coal	0	7
Coal with streaks of sulphur and shale	2	0	Coal with streaks of sulphur and shale	1	9
Total	3	9	Total	3	9

Samples for chemical analysis.—Two samples were secured in this mine for chemical analysis as a check on the car sample.

Sample A was taken at the same point that section A was measured. It was obtained by making a cut from roof to floor, exclusive of the main central parting of shale and coal, which runs from 4 to 5 inches in thickness. The lower bench of the coal contains many thin partings or streaks of impurities which were included in the sample, being too thin to be separated in actual mining. About 25 pounds of coal were obtained from this cut. This coal was crushed and quartered down to about 1 quart, which was sealed in a galvanized-iron can and mailed to the testing laboratory.

Sample B was taken at the same point where section B was measured. The sample was obtained by making a cut from roof to floor in the usual way, and was prepared in the same manner as sample A.

Character of car sample.—The car sample shipped to St. Louis for testing purposes consisted of about 20 short tons of lump coal over a 1⅛-inch bar screen and about 20 tons of slack or the coal that passed through this screen.

The object in sending two grades of coal was that the lump, which generally is used for the production of steam, could be tested in that way, and the slack could be tested for its adaptability to briquetting. About 60 per cent of the output of the mine is used by the Missouri Pacific Railway for locomotive fuel. Generally the slack is sold to the Kansas City packing houses, but it commands only a small price and a method for its better utilization would gladly be welcomed by the companies operating in the field.

The sample for testing was loaded in an ordinary gondola car, which was shipped on September 24 and received at the testing plant October 26, 1904.

Equipment.—Mine No. 4, from which this sample was obtained, lies about 1½ miles west of Coal Hill. It is within the outcrop, and the coal is reached by a shaft 135 feet deep. The coal dips somewhat toward the center of the basin, but the dip is irregular and the entries in following a regular grade are quite crooked. The coal is delivered to the foot of the shaft by mules and cable haulage.

The shale overlying the coal is hard, and it forms a good roof to the mine. The floor is hard and gives no trouble from squeezes, etc.

This company operates 4 mines in this vicinity and still has considerable undeveloped territory. The daily capacity of mine No. 4 is about 500 short tons.

ARKANSAS No. 6.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 18 at Jenny Lind, Sebastian County, Ark., on the Missouri Pacific Railway.

Sampler.—Shipped by operator.

Character of car sample.—This coal was shipped to the testing plant for special tests in briquetting and coking and consisted of slack coal from mine No. 18, the same as Arkansas No. 3.

SPECIAL SAMPLES OF ARKANSAS COALS.

Data concerning the special samples of Arkansas coals taken for chemical tests are given in the following table:

Special samples of Arkansas coals taken for chemical analysis.

Laboratory number.	Coal bed.	Mine.	Town.	County.	Owner.	Sampler.	Thickness of coal bed.		Thickness of coal.		Date.	Page of analysis.
							Ft.	*in.*	*Ft.*	*in.*		
1030	Huntington.	No. 17....	Jennie Lind..	Sebastian.	Western Coal and Mining Co.	John W. Groves.	6	0	....		Aug. 27	269
1031	....do...	.....do...	.....do........	.....do....	.....do.........	.....do..........	6	0	....		....do...	269
1040	Spadra .	No. 2.....	Denning	Franklin .	.....do.........	.....do..........	3	7	3	5	Aug. 29	269
1042	....do...	.....do...	.....do........	.....do....	.....do.........	.....do..........	4	5	3	10	....do...	269
1052	Huntington.	Cherokee No. 6.	Midland City.	Sebastian.	Cherokee Construction Co.	J. Shober Burrows.	2	10	2	10	Sept. 2	269
1054	....do...	.....do...	.....do........	.....do....	.....do.........	.....do..........	2	9	2	9	....do...	269
1066	....do...	No. 1.....	Burma	.....do....	Mammoth Vein Coal Co.	John W. Groves.	8	7	7	7½	Sept. 6	269
1068	....do...	.....do...	.....do........	.....do....	.....do.........	.....do..........	8	5	7	7	....do...	269

RESULTS OF TESTS.

The general results of tests on Arkansas coal are satisfactory. Its steam-producing quality was shown to be nearly equal to the best West Virginia coal. The great drawback in Arkansas coal is its friableness and the large amount of very fine slack that is produced in mining. The great question in this field is the better utilization of this slack coal, and many experiments were made in endeavoring to solve this problem.

In many fields slack coals can probably be best utilized in the manufacture of producer gas, but this method does not seem to be applicable to the slack coals of this region, for the reason that the coal suffers mechanical disintegration to so great an extent that a large percentage becomes fine coal, consisting of flakes rather than prisms, which packs in the producer and spoils the quality of the gas. Also Arkansas coal is a high-carbon, low-volatile coal, and producer gas made from it is of comparatively low calorific value compared with gas made from more bituminous coals and lignites. Owing to these conditions it does not seem probable that this coal can be used to great advantage in a producer-gas plant unless some method is devised to obviate the packing of the material in the producer.

The most promising results were obtained in briquetting experiments, and as the coals of this district are all of the same general character it is probable that the results obtained on the coal sent to the testing plant will be equally applicable to the coal produced at other mines of the district.

With 6 per cent of hard pitch excellent briquettes were made with Arkansas No. 4 slack coal, and this result could probably be duplicated with any other coal in the district. With this small percentage of pitch, briquetting seems to be commercially possible, and it may open a way for the better utilization of slack coal and the introduction of a desirable substitute for anthracite coal.

The results obtained in coking briquettes made of coal from Jenny Lind mine with 6 per cent pitch indicates another possible use for slack coal from this district, but in this use the original character of the coal seems to be an important element, and it may not be successful with higher fixed carbon coals.

COLORADO.

Colorado is the most important coal-producing State west of Mississippi River. In 1904 its output was 6,658,355 short tons of coal. The coal fields of the State have been divided into three groups—Eastern, Park, and Western. Coal beds occur in the uppermost formations of the Cretaceous system, but generally they are most abundant in the Laramie rocks, which constitute the extreme top of the system.

The Eastern coal group consists of three separate fields lying along the eastern foothills of the Front Range. They are generally known as the Raton, Canyon City, and South Platte fields.

The South Platte coal field extends along the Front Range from Colorado Springs nearly to the northern boundary of the State. It is naturally divided into two parts, a northern and a southern district. The first is decidedly the more important and includes the mining centers of Boulder, Marshall, Erie, Lafayette, and Louisville. Along the western margin of this field the coal-bearing rocks are steeply upturned, but toward the east they soon flatten out. Locally they are considerably disturbed by faulting and to some extent by igneous intrusions.

Although the coal of this field is a black lignite which slacks so readily when exposed to the air that storage or transportation to great distances is impossible, it is extensively mined for the Denver market and is an important source of fuel for the general region east of the mountains.

The coal sent to the testing plant was obtained at Lafayette from the Simpson mine of the Northern Coal and Coke Company.

COLORADO No. 1.

Operator.—Northern Coal and Coke Company, Denver, Colo.

Mine.—Simpson mine, Lafayette, Boulder County, Colo., on the Chicago, Burlington and Quincy and Colorado and Southern railroads.

Sampler.—Frank W. De Wolf.

Coal bed.—The coal bed from which the sample was taken is one of a number belonging to the Laramie formation. This formation, in the vicinity of Denver, is from 1,000 to 1,200 feet thick. The workable coal beds are confined to the lower part of the formation, which, so far as known, contains from one to four beds. A number of faults occur in the vicinity of Lafayette. Some of them show a displacement so great that the extension of the mine workings is impossible. The character of the coal is essentially lignitic, but in appearance it is black and lustrous, and possesses a structure more like block coal than lignite. Two measurements of this bed, shown in fig. 3, were taken in the Simpson mine. Section A was measured in room 5, off the fourth northwest entry, and section B was measured in room 23, off the twenty-third southwest entry.

Sections of coal bed in Simpson mine, Northern Coal and Coke Company, Lafayette, Colo.

Section A.		Section B.	
	Feet.		*Feet.*
Coal	11	Coal	14

Samples for chemical analysis.—Two samples were obtained in the Simpson mine for chemical analysis. Sample A was obtained at the point where section A was measured and sample B at the point where section B was measured. The coal was obtained by cutting a section from roof to floor. It was then reduced to a uniform size of one-half inch in diameter for the largest fragments, and the sample was then quartered down until about 5 pounds remained. These small samples were sealed in galvanized-iron cans and mailed to the chemical laboratory of the testing plant.

Character of car sample.—Run-of-mine coal was shipped to the plant for testing. The coal was bright and clean, and a large percentage of it was lump coal. The coal weathers or slacks very easily on exposure to the atmosphere, and for that reason very little of it is mined during the summer months. The coal was loaded in an ordinary open coal car, which was shipped from the mine November 4 and received at the testing plant November 19, 1904.

Equipment and use.—The Simpson mine has good railroad facilities, as it has connection with the Chicago, Burlington and Quincy Railroad, and also the Colorado and Southern Railroad. The mine workings are reached by a shaft 240 feet deep, from the bottom of which entries radiate in all directions. The rooms are turned off from these entries. The entire mine is lighted by electricity. Electric haulage is used on the main roads, and all of the coal is cut by electric machines. A large percentage of the coal shipped from this mine is used for steam purposes in the vicinity of Denver, and for locomotive fuel by the railroads, while about 5 per cent is sold for domestic purposes. The maximum daily output of the mine is approximately 1,400 tons, but the daily average for the year is greatly lowered by the almost total suspension of operations during warm weather.

RESULTS OF TESTS.

Owing to the tendency to slack when exposed to the weather, this coal is not available except for use in near-by localities. The principal need of the field is some process for the better utilization of the lignite, which is really valuable, but which under present conditions is limited to local use.

The progressive operators have been looking forward anxiously to the introduction of some process of successfully briquetting the coal, but so far without success. Although some experiments were tried at St. Louis, nothing was found in the limited time at hand to encourage briquetting, but tests made in the gas producer and gas engine showed that by this method Colorado lignite could be used to much greater advantage in the production of power than as steam coal or in any form of briquette.

The results given on page 424 show that for the production of one electrical horsepower hour by the steam plant 4.85 pounds of dry coal were consumed, while for the production of the same amount of energy in the producer-gas plant and gas engine only 1.71 pounds of dry coal were consumed. This shows a gain in efficiency of 183 per cent. Also the results of steam tests on page 372 show that of the best West Virginia coal 3.39 pounds of dry coal were required for

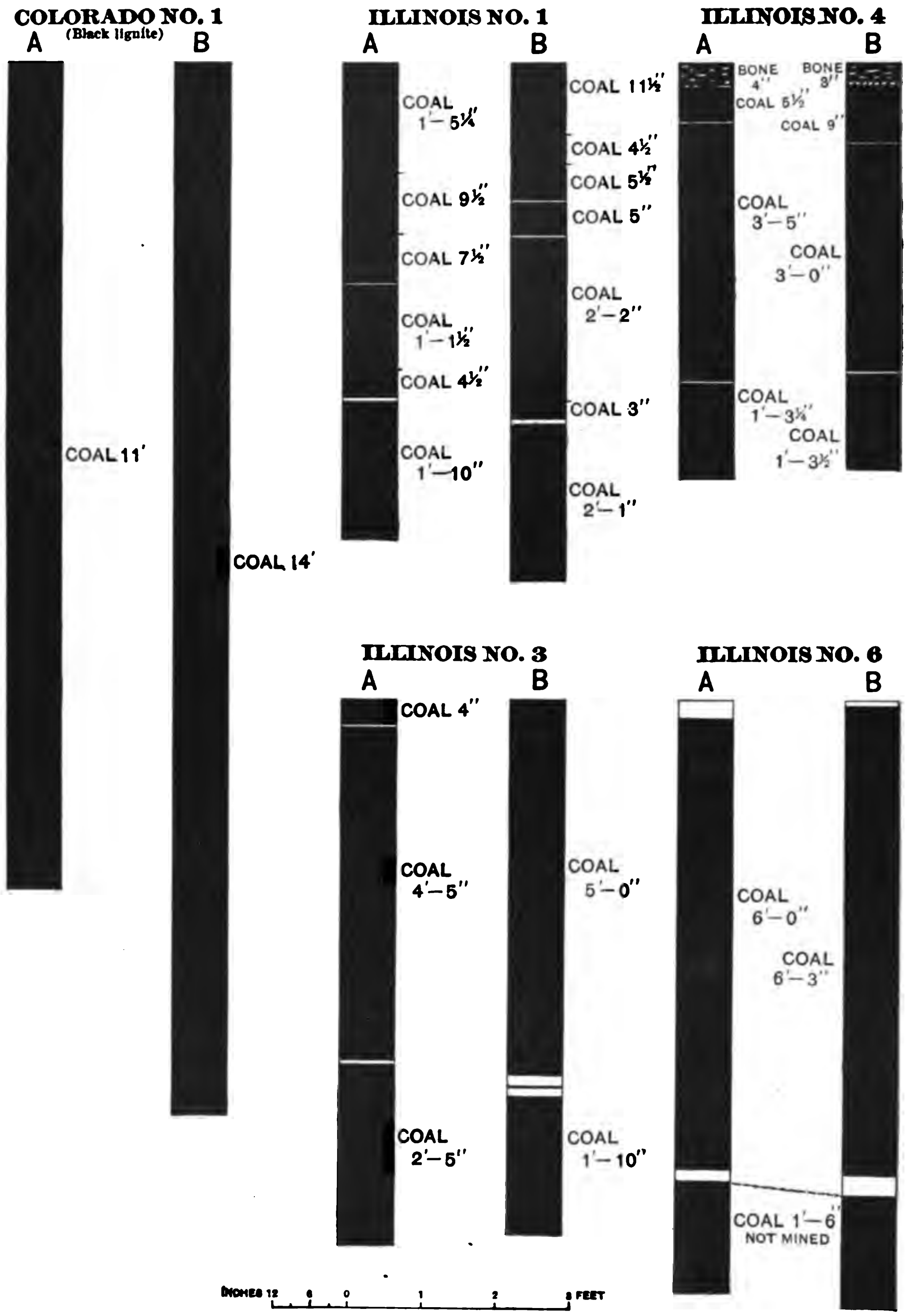

FIG. 3.—Sections of Colorado and Illinois coal beds.

the production of one electrical horsepower hour; therefore it is plain that in the producer-gas plant better results were achieved with Colorado lignite than with the best West Virginia coal in the steam plant.

With the perfection of the gas engine this method of producing power will undoubtedly come into common use, and then beds of such lignite as Colorado No. 1, lying in close proximity to a manufacturing center like Denver, will be of the greatest value. The results obtained on this coal can doubtless be duplicated on most of the lignites of the State.

ILLINOIS.

Illinois is second in importance among the coal-producing States, yielding, according to the report of Mr. E. W. Parker,[a] 36,475,060 short tons of coal in 1904. The coal is not of so high grade as that from the Appalachian region, but the proximity of this field to the great manufacturing centers of Chicago and St. Louis has led to extensive development and to the great output noted above.

Illinois includes the greater part of the eastern interior coal field, which stretches from Rock Island and Wilmington, Ill., on the north to central Kentucky on the south, and from the Mississippi River on the west to Williamsport and Cannelton, Ind., on the east. The coal field of Illinois has the form of an elongated basin, whose major axis extends in nearly a north-south direction from the vicinity of Hennepin on the north to the mouth of the Wabash River on the south. As a rule the higher coal beds occur in the central part of the basin and the lower coal beds around the margin of the field.

In the original geologic survey of the State the coal beds were numbered in consecutive order, beginning at the base of the coal-bearing rocks. Of this series, coal beds designated 2, 3, 4, 5, 6, and 7 are of workable thickness. In many places the coal-bearing rocks of the State rest unconformably upon the older rocks, and it has been extremely difficult to make exact correlation of the various coal beds. Local names are therefore generally used for the coal beds from which coal was shipped for testing, and when numbers are given it must be understood that the correlation is tentative only, or is that which is commonly used in the district.

The coal tested came from three districts, which may be best designated by the names of the counties in which they were mined, as follows: (1) Marion, (2) Montgomery, and (3) Madison-St. Clair.

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[a] Mineral Resources of the United States, 1904.

Illinois No. 1.

Operator.—Western Anthracite Coal and Coke Company, St. Louis, Mo.

Mine.—St. Louis and O'Fallon No. 1 (Nigger Hollow) mine, located 5½ miles west of south of O'Fallon, Ill., on private railroad connecting mine with East St. Louis.

Sampler.—Marius R. Campbell.

Coal bed.—The bed of coal here worked is called the Belleville seam. It is correlated with coal No. 6 and is the most extensively developed and most important bed in Madison and St. Clair counties. It ranges in thickness from 5½ to 7½ feet, and averages over 6 feet. It is mined at depths varying from 50 to 300 feet, but most of the larger mines are from 100 to 200 feet deep. Two sections, which are represented graphically in fig. 3, were measured in this mine. Section A was measured at a point 1,200 feet north of the shaft and section B 1,200 feet south of the shaft. The sections are as follows:

Sections of coal bed in mine of Western Anthracite Coal and Coke Company, near O'Fallon, Ill.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	1	5¼	Coal	0	11½
Sulphur knife edge.			Sulphur knife edge.		
Coal	0	9½	Coal	0	4½
Sulphur knife edge.			Sulphur knife edge.		
Coal	0	7½	Coal	0	5½
Shale	0	0½	Bone	0	0½
Coal	1	1½	Coal	0	5
Sulphur knife edge.			Slate	0	0½
Coal	0	4	Coal	2	2
Shale	0	1	Sulphur knife edge.		
Coal	1	10	Coal	0	3
			Slate	0	1
			Coal	2	1
Total	6	3¼	Total	6	10½

Samples for chemical analysis.—Two samples were collected in the mine for chemical analysis. Sample A was obtained at the point where section A was measured and sample B at the point where section B was measured. At these working faces the loose coal was stripped off and a perpendicular cut made from roof to floor. This cut was about 2 inches wide and about 1 inch deep. All of the partings discarded by the miner were carefully thrown out and only the parts of the bed furnishing coal for the market were included. In this way representative samples were obtained. These samples, which in their original bulk amounted to about 25 pounds per sample, were crushed and quartered down until they weighed about 5 pounds each. Each sample was then packed in an air-tight galvanized-iron cylinder and mailed to the chemical laboratory of the testing plant.

Character of car sample.—The coal loaded for shipment to the testing plant was passed over a 1-inch perforated screen. This kind of coal constitutes lump and nut in the market and is mixed and sold for railroad engine coal. The car was not loaded in the presence of the sampler, but was selected by him from a number standing already loaded on the mine siding. It was regarded as containing representative coal. The car was loaded September 13 and was received at the testing plant September 23, 1904.

Equipment and use.—Mine No. 1 is reached by a shaft 140 feet deep. The coal is mined by hand by the room-and-pillar system, and hauling is done by mules. When the coal arrives at the tipple it is run over a 1-inch perforated screen, and the slack is separated from the lump and nut. Most of the lump and nut is sold to the various railroads entering East St. Louis for locomotive coal, while the slack finds a ready market at the large electric power houses in St. Louis. The daily output of this mine is approximately 1,500 tons. The coal company owns a line of railroad connecting its mine with the yards of East St. Louis, and by this line the coal can easily and cheaply be delivered to the bridge companies or to the eastern railroads which center at this point.

ILLINOIS NO. 2.

Operator.—Western Anthracite Coal and Coke Company, St. Louis, Mo.

Mine.—St. Louis and O'Fallon (Nigger Hollow) mine No. 1, 5½ miles west of south of O'Fallon, Ill.

Sampler.—Marius R. Campbell.

Character of car sample.—This sample consisted of a car of slack coal from the same mine that Illinois No. 1 was obtained. The slack from this mine is all shipped to St. Louis for use in the large power houses of the transit company. It seemed possible that washing might greatly improve the quality of the slack, hence the car was shipped for a washing test. For description of the mine and the coal bed, see page 55. This car was shipped from the mine September 16, and it was received at the testing plant September 26, 1904.

ILLINOIS NO. 3.

Operator.—Southern Illinois Coal Mining and Washing Company, Chicago, Ill.

Mine.—Mine No. 3, located at Marion, Williamson County, Ill., on the Chicago and Eastern Illinois Railroad.

Sampler.—John W. Groves.

Coal bed.—The coal bed mined at Marion is known locally as the Carterville coal, and it probably corresponds to bed No. 7 of the State geological reports. The coal bed underlies the northern half of Williamson County at depths ranging from 0 to 150 feet, and it varies in thickness from 4 to 9 feet. Two sections, shown in fig. 3, were measured in this mine. Section A was measured in the third southwest entry and section B was measured in the first north entry on the east side of the mine. The sections are as follows:

Sections of coal bed in mine No. 3, Southern Illinois Coal Mining and Washing Company, Marion, Ill.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	0	4	Coal	5	0
Shale	0	1	Sulphur	0	2
Coal	4	5	Shale	0	1½
Shale	0	1	Coal	1	10
Coal	2	5	Total	7	1½
Total	7	4			

Samples for chemical analysis.—Two samples were procured in this mine for chemical analysis. Sample A was obtained at the point where section A was measured and sample B where section B was measured. The samples were obtained by making cuts from roof to floor and throwing out the partings discarded in mining the coal for commercial use. These samples weighed about 25 pounds each in their original bulk. They were crushed and quartered, however, until each was reduced to about 5 pounds of fine material, which was packed in air-tight galvanized-iron cylinders and mailed to the chemical laboratory at the testing plant.

Character of car sample.—A car of run-of-mine coal was loaded and shipped to the plant for testing purposes. The coal was reasonably free from impurities and representative in character. The coal was loaded on an open coal car which was shipped from the mine October 3 and was received at the testing plant October 23, 1904.

Equipment and use.—This mine is worked by the room and pillar double-entry system. It is connected with the surface by a 90-foot shaft. The coal is hauled by mules. About 60 per cent is cut by electric machines and the rest by hand. With this equipment about 1,500 tons of coal are mined daily. About 50 per cent of the product is sold for domestic use, while the rest goes for factory purposes and railroad coal. The coal is nearly all sold through Chicago to the Northwest.

ILLINOIS No. 4.

Operator.—Donk Brothers Coal and Coke Company, St. Louis, Mo.

Mine.—Mine No. 3, located about 1 mile west of Troy, Madison County, Ill., on the St. Louis, Troy and Eastern Railroad, a private line connecting these mines with East St. Louis.

Sampler.—Marius R. Campbell.

Coal bed.—In Madison and St. Clair counties the principal coal is known as the Belleville bed. Although it is difficult to determine the exact stratigraphic position of this bed, it is generally correlated with coal No. 6 of the State reports. Two sections, shown in fig. 3, were measured in this mine. Section A was measured in room 15 off the fifth west entry on the north side of the shaft. Section B was measured in room 16 off the fifth east entry on the south side of the shaft.

Sections of coal bed in mine No. 3, Donk Brothers Coal and Coke Company, Troy, Ill.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Bony coal	0	4	Bony coal	0	3
Coal	0	5½	Coal	0	9
Shale	0	¼	Shale knife edge.		
Coal	3	5	Coal	3	0
Shale	0	¾	Shale	0	¾
Coal	1	3¼	Coal	1	3½
Total	5	6¾	Total	5	4¼

Samples for chemical analysis.—Two samples for chemical analysis were taken in this mine. Sample A was obtained at the point where section A was measured and sample B was obtained at the point where section B was measured.

To obtain these samples loose coal and powder smoke were removed from working faces of coal, and cuts were made from roof to floor, exclusive of the bony coal at the top of the bed and the lowest shale parting, three-fourths inch thick. The material resulting from these cuts amounted to 25 or 30 pounds per sample. These bulky samples were taken from the mine and carefully pulverized and quartered down to about 5 pounds in weight and then packed and sealed in galvanized-iron cylinders and mailed to the testing plant.

Character of car sample.—At this mine the coal is screened over a 2-inch perforated screen. That which passes over the screen is sold for steam and domestic use, and that which passes through is washed and separated into various grades of commercial coal. Since all of the slack is washed it would have been unjust to this plant to test run-of-mine coal, and therefore the car was loaded with coal over the 2-inch perforated screen. The coal was loaded in an ordinary open coal car, which was shipped from the mine October 31 and was received at the testing plant November 3, 1904.

Equipment.—This company operates three mines in the Belleville district. Mine No. 1 is located near Collinsville, mine No. 2 at Marysville, and mine No. 3 near Troy. The company owns the St. Louis, Troy and Eastern Railroad, by which the mines are connected with East St. Louis.

Mine No. 1 is equipped with a washery to which the slack coal is brought from the other mines and washed into four grades of coal, which find a ready market. The fifth and finest grade is not salable, and the company contemplates the erection of a bank of coke ovens to utilize, if possible, this fine coal.

At mine No. 3 the coal is reached by a shaft 273 feet deep. The coal is mined by hand and is delivered to the foot of the shaft by electric haulage, except in the side entries, where mules are used.

The estimated capacity of mine No. 3 is 1,800 tons per day, and it is run almost to its capacity.

ILLINOIS NO. 5.

Operator.—Donk Brothers Coal and Coke Company, St. Louis, Mo.

Mine.—Mine No. 1, located near Collinsville, Madison County, Ill., on the St. Louis, Troy and Eastern Railroad.

Sampler.—Marius R. Campbell.

Coal bed.—This mine is on the same bed as mine No. 3, described under Illinois No. 4. The mine was not examined and consequently no section of the coal bed was obtained, nor were any samples procured for chemical analysis.

Character of car sample.—This coal was tested only to determine the possibility of coking the finest grade of washed slack, which at present is waste material.

The slack from the three mines of this company is washed at the No. 1 plant and separated into five grades of commercial coal. The smallest size or grade is known as "No. 5 washed," and the particles of coal are all less than one-quarter inch in diameter. The sample for testing consisted of this "No. 5 washed coal."

The washery at this plant is run to the full limit of its capacity, and the result is that some of the coal, especially the smaller grades, are not thoroughly washed, for a thin coating of mud is left on the coal, giving it the appoarance of fine fragments of clay.

The coal was loaded in an ordinary open coal car which was shipped from the mine on October 31 and was received at the testing plant November 17, 1904.

ILLINOIS No. 6.

Operator.—Clover Leaf Coal Company, Coffeen, Montgomery County, Ill.

Mine.—Clover Leaf shaft No. 1, located at Coffeen, Montgomery County, Ill., on the Toledo, St. Louis and Western (Clover Leaf) Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal worked in this mine was designated by the Geological Survey of Illinois as coal bed No. 5, but is known locally as the Pana and also as the Springfield coal. In Montgomery County the coal varies in thickness from 6 to 8 feet and lies at a depth ranging from 440 feet at Hillsboro to 684 feet at Litchfield. In Clover Leaf mine No. 1 the depth of the shaft is 550 feet and the bed averages 7 feet 6 inches in thickness. Two sections, shown in fig. 3, were measured in this mine. Section A was measured at the face of room 21, off the sixth left entry, and section B was measured at the face of room 18, off the fourth right entry, some distance from section A.

Sections of coal bed in Clover Leaf mine No. 1, Clover Leaf Coal Company, Coffeen, Ill.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Slate	0	3	Slate	0	1
Coal	6	0	Coal	6	3
Blue (limestone?)	0	2	Blue (limestone?)	0	3½
Coal	1	6	Coal	1	6
Total	7	11	Total	8	1½

Samples for chemical analysis.—Two samples were collected from this mine for chemical analysis, and they are designated sample A and sample B. The points from which these samples were taken are identical with the location of sections A and B. In obtaining the samples the method of procedure was as follows:

A smooth face having been selected at a point in the mine in which the coal appeared to be normally developed, all loose and weathered coal was removed from a space 2 to 3 feet wide across the full thickness of the bed. A cut about 2 inches wide and 1 inch deep was then made across the face from roof to floor, including everything noted in the above sections except the draw slate above the coal and the parting near the bottom of the bed, which are thrown out by the miners, and therefore do not belong in the commercial product of the mine. About 25 pounds of material was obtained in this way for each sample. These were pulverized and quartered down to 4 or 5 pounds and packed separately in galvanized-iron cans, which were sealed and sent to the laboratory for analysis.

Character of car sample.—The car of coal for testing was selected at random by the sampler from a number of loaded cars standing on the side track. This was done to facilitate the shipment of the car, as a broken switch point prevented the shifting of empty cars under the tipple. The car selected was an ordinary gondola and contained run-of-mine coal, the principal grade shipped at this mine. The car was shipped from the mine November 18 and it was received at the testing plant December 2, 1904.

Equipment and use.—Clover Leaf mine No. 1 has been in operation for sixteen years, and it is reported that sufficient coal remains on the property to warrant operating this mine for about two years more. The company is sinking a new shaft near Coffeen and will install an equipment with a larger capacity than that of mine No. 1. The coal in mine No. 1 is reached by a shaft 550 feet deep. The mine is laid out on the room-and-pillar system. The coal is shot from the solid and hauled to the bottom of the shaft by mules.

The capacity of the mine is rated at 450 tons a day and most of the product is used by the Toledo, St. Louis and Western Railroad (Clover Leaf route), upon which the mine is located. The balance is distributed locally in Illinois and Indiana for domestic and factory uses.

RESULTS OF TESTS.

For steaming purposes the results show that the Illinois coals which were tested are about the average, the best results being obtained with the coal from Williamson County. In this connection it is well to remember that the figures are the results of one test only on each sample, and it is probable that in many cases the maximum efficiency was not obtained.

Only one washing test was made, and that was on Illinois No. 2, a carload of slack from the O'Fallon mine. The result of this test is given on page 440, and the steam tests on the washed and on the unwashed coal give a practical demonstration of the improvement made by washing.

The producer-gas tests show that excellent results may be obtained from Illinois coal when used in a producer plant and gas engine. It seems probable also that much if not all of the slack coal could be utilized in this way and thus obviate the loss of revenue that at present is experienced from the inability to market this coal at its real fuel value or from the expenditure necessary to briquette it and make it a commercial fuel.

The best result obtained in the steam plant was 3.39 pounds (see p. 872) of West Virginia dry coal per electrical horsepower hour developed at the switchboard, while in the producer plant and gas engine only 1.79 and 1.76 pounds, respectively, of Illinois coal were used to produce the same result. If these figures are verified in practice, and there seems to be no doubt that this is possible, Illinois coal used in such a plant will give much better results than the best West Virginia coal used in a steam plant.

Briquetting tests, although not conclusive, seem to show that it is possible to briquette the coal on a commercial scale, and thus to produce good domestic fuel from the slack coal. Further tests are necessary to determine the range of binding material and the cost of production.

Coking tests were made on Illinois No. 5, but with unsatisfactory results. The fine coal that was tried at the testing plant seemed to be too thoroughly coated with a film of clay to allow the particles to cohere. It is reported that coke was once made by heating the ovens to a high temperature with other fuel, but this would probably render the process too expensive for ordinary use even if the waste coal of "No. 5 washed" could be coked by this process.

INDIANA.

Indiana is one of the great coal-producing States of the Union, standing sixth in the list in 1904, with a production of 10,934,379 short tons of coal.

The coal-bearing territory of Indiana is a part of the eastern interior coal field, which includes almost all of Illinois south of the latitude of Chicago, the southwestern corner of Indiana, and about ten counties in western Kentucky. The central part of the basin is in Illinois, so the coal beds in Indiana dip gently to the west, and, as a rule, the oldest and lowest coals are exposed along the eastern margin of the field.

The Indiana field contains a number of coal beds, but they are variable in thickness and uncertain in occurrence. Those in the lower part of the geologic section are very irregular and are worked at only a few places along the eastern margin of the field.

Of the beds higher in the series the Brazil block coal is perhaps the most noted, but the thicker and more persistent beds occur still higher. Coal No. 5 (numbering from the base of the measures) is the most prominent and valuable bed in the southern part of the State in the Evansville region. It is extensively mined in Warrick County. The sample known as Indiana No. 2 is from a mine in this coal bed near Boonville.

Farther north coal No. 6 is more prominent, and the sample marked Indiana No. 1 is from a mine in this bed in the vicinity of Sullivan, Sullivan County, Ind.

INDIANA No. 1.

Operator.—J. Wooley Coal Company, Evansville, Ind.

Mine.—Mildred mine, Mildred, Sullivan County, Ind., on the Evansville and Terre Haute Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The bed worked at Mildred is known as coal No. 6. This coal underlies Sullivan County apparently as a continuous bed, averaging about 6 feet in thickness. From its outcrop east of Sullivan County it dips toward the west, being at a depth of from 130 to 140 feet in the vicinity of Mildred.

The two sections shown in fig. 4 were obtained in the Mildred mine. Section A was measured at the face of room 4 off the southwest entry and section B was measured some distance east of section A at the face of room 5 off the southeast entry.

Sections of coal bed in Mildred mine, J. Wooley Coal Company, Mildred, Ind.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	2	5	Coal	2	2
Shale	0	½	Shale	0	¼
Coal	0	6	Coal	0	6¼
Shale	0	1	Shale	0	¾
Coal	2	2	Coal	2	2
Bony coal[a]	1	0	Bony coal[a]	1	¾
Total	6	2½	Total	6	0

[a] Not mined.

Samples for chemical analysis.—Two samples were taken from this mine for chemical analysis, one from the point at which section A was measured and the other from the point at which section B was measured. In obtaining the samples for analysis the above-mentioned locations were selected after a general inspection of the mine, as most nearly representative of the coal. The face of each room was cleared of all loose and weathered coal, and cuts were made from roof to floor across the face, excluding the partings and bony coal shown in the sections. The material from these cuts, which amounted to about 30 pounds per sample, was then pulverized and quartered down to about 5 pounds, packed in air-tight galvanized-iron cans, and mailed to the chemical laboratory.

Character of car sample.—The car shipped to the testing plant from this mine was of the ordinary gondola type and contained 15 tons of run-of-mine coal to be used in making steam tests and 15 tons of coal that had passed through a

3½-inch screen to be used in making washing tests. The object of shipping the coal that passed through the screen was to determine by experiment if the quality of this grade could not be improved. The car was shipped from the mine on November 11 and it was received at the testing plant November 22, 1904.

Equipment and use.—The Mildred mine is new, having been in operation little more than a year. The J. Wooley Coal Company controls enough territory adjacent to the present opening to last for eighteen or twenty years, and it intends to make this mine a large producer. The shaft is 139 feet deep and from its bottom a main entry runs due north and south. From this main entry side entries are turned off in the regular way, following the room-and-pillar method of mining. The coal is all cut by compressed-air punching machines and one air chain machine, which is giving excellent results. Mules are used to haul the coal to the foot of the shaft, and with this equipment it is expected that the output will be 600 tons a day. The coal is being used at present for domestic and steam purposes, but in what proportion it is difficult to determine, as the output during the last year was small.

INDIANA NO. 2.

Operator.—T. D. Scales Coal Company, Boonville, Warrick County, Ind.

Mine.—Electric mine, located near Boonville, Warrick County, Ind., on the Southern Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The seam mined at Boonville is coal No. 5. It averages 6 feet thick in this region and is characterized by a roof of black sheety shale overlain by limestone. It is free from persistent partings, as shown in fig. 4 by two sections measured at widely separated points in the Electric mine. Section A was measured in room 4 off the north entry and section B was measured at the face of room 8 off the south entry.

Sections of coal bed in Electric mine, T. D. Scales Coal Company, Boonville, Ind.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	7	0	Coal	7	6

Samples for chemical analysis.—Two samples of coal for chemical analysis were obtained from this mine at the points where the above sections were measured. Sample A corresponds with section A and sample B with section B. The samples were obtained in the usual way—by making a cut across the face of the coal from roof to floor after having removed from the face all loose and

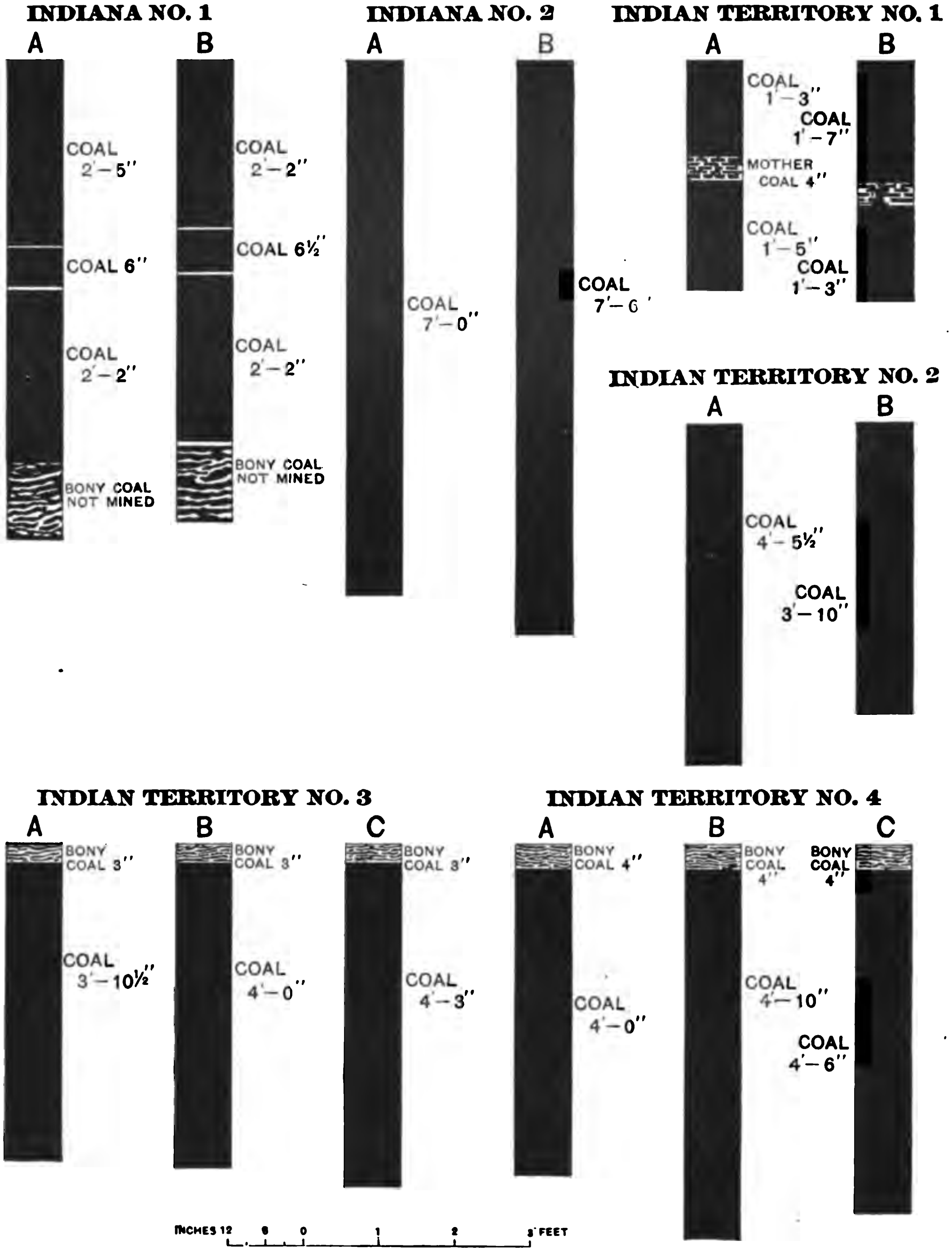

FIG. 4.—Sections of Indiana and Indian Territory coal beds.

weathered coal. The samples, each consisting of from 25 to 30 pounds of coal, were pulverized and quartered down until a quart sample was obtained from each. These were sealed in galvanized-iron cans and mailed to the chemical laboratory at the testing plant.

Character of car sample.—The car shipped from this mine was one of the hopper variety and contained run-of-mine coal of the same quality as that shipped for commercial purposes. The amount of large coal in this car was approximately 60 per cent. By large coal is meant all sizes above the grade of slack. This coal was quite free from slate and other impurities. The car was shipped from the mine on November 12 and was received at the testing plant November 23, 1904.

Equipment and use.—The Electric mine is one of the important new operations that has come into prominence in the last year in the Boonville field. It derives its name from the fact that all the coal is cut by electric machines. The coal is mined by the room-and-pillar method and hauled by mules to the bottom of the shaft, 41 feet below the surface. The capacity of this mine is 650 tons a day and most of the output is used for railroad and domestic consumption. Some of the product finds its way to the large cities of the Middle West.

SPECIAL SAMPLES OF INDIANA COAL.

Two samples were cut in the mine of the Big Four Coal Company, at Boonville, Ind. The coal bed is the same as that from which Indiana No. 2 was obtained, and its thickness and character are about the same in the two mines. Sample 1424 was taken from a point 35 yards from the working face in the main west entry and sample 1427 from room No. 9 off main west entry. These samples were taken by Mr. J. Shober Burrows on November 12, 1904.

RESULTS OF TESTS.

The steam tests on Indiana coal, although probably not developing the greatest efficiency, seem to show that the coal is about an average of those tested. The average of all the coals tested is 8.07 pounds as "equivalent evaporation from and at 212° F. per pound of dry coal," whereas 8.02 pounds were evaporated with Indiana No. 2 raw and 8.45 with Indiana No. 1 washed.

The washing operations on Indiana No. 1 show a marked improvement in both the chemical composition of the coal and in its steam-producing qualities. Undoubtedly washing could be carried on to advantage in this district.

The briquetting tests show that these coals are easily briquetted, but it is probable that under present conditions the cost is prohibitive.

The producer-gas tests on Indiana coals gave fairly good results. The sulphur in the coal is troublesome, but probably it can be successfully eliminated. The gain in efficiency over the same coals used in the steam plant is over 100 per cent, and over the best West Virginia coal used in the steam plant is 80 per cent in one case and 110 per cent in the other.

INDIAN TERRITORY.

The coal production of Indian Territory has grown from 120,947 short tons in 1880, when the first record was kept, to 3,046,539 short tons in 1904. It is now one of the important coal-producing States west of the Mississippi River, although its production in 1903 was only 1 per cent of the total product of the United States.

The principal coal field in the Territory is the McAlester field, which lies in a series of basins in the southern part of the Territory. These form a westward prolongation of the basins described in the Arkansas report, and extend southwestward from the Arkansas State line to Atoka.

The samples marked Indian Territory Nos. 2, 3, 4, 5, and 6 came from this field.

In this field there are two principal coal beds, separated by about 1,300 feet of strata. These are known in a general way as the McAlester and Hartshorne coals.

The Hartshorne coal occurs at the base of the coal-bearing rocks and is represented by the sample called Indian Territory No. 2. This came from Hartshorne and may be regarded as the type coal. Samples Nos. 3, 4, 5, and 6 were obtained at Edwards, Lehigh, and Coalgate, in other parts of the basin, from beds which occur at about the horizon of the McAlester bed. The local names in use are Lehigh, Atoka, etc. The horizon of these beds is about 1,300 feet above the Hartshorne bed.

The coal-bearing rocks of the McAlester field are really connected with the Coal Measures of Kansas, but the intermediate area in the northern part of the Territory contains only a few thin beds and consequently little exploration has been done and the field is not well known. The sample marked Indian Territory No. 1 came from Henryetta, which is located between Canadian River on the south and Arkansas River on the north in this intermediate zone. With the present knowledge respecting this part of the field it is impossible to correlate the Henryetta coal with any of the coal beds of the McAlester field.

INDIAN TERRITORY NO. 1.

Operator.—Whitehead Coal Mining Company, Henryetta, Ind. T.
Mine.—Mine No. 1, located at Henryetta on the Frisco Railroad.
Sampler.—J. Shober Burrows.

Coal bed.—The coal beds of the southern part of the Territory have not been traced into this part of the field nor have those of Kansas been traced this far south. As a result little is known about the stratigraphic position of this bed or its correlation with the coal beds of adjacent fields.

The thickness and character of the bed in the Henryetta mine are shown in fig. 4 by two sections. Section A was measured at the face of the northeast entry; section B was measured at the face of the southeast entry. The sections are as follows:

Sections of coal bed in mine No. 1, Whitehead Coal Mining Company, Henryetta, Ind. T.

Section A.

	Ft.	in.
Coal	1	3
Mother coal	0	3½
Coal	1	5
Total	2	11½

Section B.

	Ft.	in.
Coal	1	7
Mother coal	0	4
Coal	1	3
Total	3	2

The mother coal noted in the sections is characteristic of this bed. It consists of structureless, dull-black carbonaceous matter which resembles crushed charcoal and is almost pure carbon.

Samples for chemical analysis.—Two samples for chemical analysis were taken from this mine, one from the point where section A was measured and one from the point where section B was measured. In obtaining these samples the face was first stripped of loose and weathered coal, then in this prepared space a section was cut from roof to floor yielding about 20 pounds of coal for each sample. These bulky samples were carefully crushed and quartered down, until the original bulk was represented by 4 or 5 pounds of material. These ultimate samples were sealed in air-tight cylinders and mailed to the chemical laboratory.

Character of car sample.—The car was first loaded with 50 per cent of lump coal, which was carefully picked for slate and impurity, and on top of this 50 per cent of slack coal. The amount of slack which the mine yields is excessive, but it is due largely to the band of mother coal which occurs about the middle of the bed and which breaks up into a fine powder. The mine being a new one at the time the sample was collected, nothing but entry coal was available, and consequently a great deal of slate and clay came from the mine with the coal. It is expected that when rooms are worked the commercial output will be very much improved. The coal was loaded in an ordinary gondola car, which was shipped from the mine September 6 and was received at the testing plant September 21, 1904.

Equipment and use.—At the time the shipment was made this mine had been operated constantly for about four months. The room-and-pillar method of working is employed and entrance is by a shaft 98 feet deep. The coal is hauled to the foot of the shaft by mules and is all cut by hand. Only 75 tons a day was the output at the time the mine was visited, but as noted above, entries were being driven and much time was taken up by dead work. The company owns a large acreage of coal at this point, and there is every reason to suppose that the mine will be a good producer. The product is shipped over the Frisco road to points in Texas, Oklahoma, and Indian Territory, and some is used as engine coal by this system.

INDIAN TERRITORY No. 2.

Operator.—Rock Island Coal Company, Hartshorne, Ind. T.

Mine.—Mine No. 8, located at Hartshorne, Ind. T., on the Choctaw, Oklahoma and Gulf (Rock Island) Railroad.

Sampler.—John W. Groves.

Coal bed.—The coal being mined in No. 8 mine is called the Hartshorne bed, from this place. It is a clean coal of uniform thickness occurring about 250 feet below the surface at this point. Two sections of this coal bed are shown in fig. 4. Section A was measured in room 14 off the main east entry and section B was measured in room 16 off the seventh west entry. The sections are as follows:

Sections of coal bed in mine No 8, Rock Island Coal Company, Hartshorne, Ind. T.

Section A.	*Ft.*	*in.*	Section B.	*Ft.*	*in.*
Coal	4	5½	Coal	3	10

Samples for chemical analysis.—Two samples were cut in this mine for chemical analysis. Sample A was obtained at the same place that section A was measured and sample B at the same place that section B was measured. These samples were procured in the usual manner by making a cut from roof to floor. The material obtained was crushed and quartered to about 1 quart in size, and then the samples were packed in galvanized-iron cylinders, which were sealed and mailed to the chemical laboratory at the testing plant.

Character of car sample.—Run-of-mine coal was accepted for testing purposes. The car contained a considerable amount of shale, derived from the soft shaly clay floor, which crumbles into small fragments. In mining, a large amount of this soft clay floor is loaded into the mine cars with the coal. Ordinarily this passes through the screens and is mixed with the finer grades of coal, but in the run-of-mine accepted for testing the clay remains and consequently the percentage of ash is materially increased. The coal for testing was loaded in a gondola car, which was shipped from the mine September 8 and received at the testing plant September 26, 1904.

Equipment and use.—The coal is reached by a shaft 250 feet deep, and is mined by the room-and-pillar system. It is hauled by rope and by mules. Mining is carried on without the use of machines, most of the coal being shot off the solid. About 600 tons of coal a day are produced, all but about 9 per cent going to the Rock Island system for engine coal. The remainder is sold for steam purposes and household use except about 3 per cent, which is consumed locally or made into coke.

INDIAN TERRITORY No. 3.

Operator.—D. Edwards & Son, Edwards, Ind. T.

Mine.—Mine No. 1, located at Edwards, on the Choctaw, Oklahoma and Gulf (Rock Island) Railroad.

Coal bed.—It is difficult to trace the outcrop of this coal bed and therefore its position is not well known. It is supposed, however, to be the McAlester bed. The coal consists of one solid bench, free from binders or partings. It is overlain by about 3 inches of bony coal, which appears to be a characteristic feature in this mine. The character and thickness of the coal bed are shown in fig. 4 by two sections. Section A was measured in the second west air course and section B was measured in the second east air course. The sections are as follows:

Sections of coal bed in mine No. 1, D. Edwards & Son, Edwards, Ind. T.

Section A.	Ft.	in.	Section B.	Ft.	in.
Bony coal	0	3	Bony coal	0	3
Coal	3	10½	Coal	4	0
Total	4	1½	Total	4	3

Samples for chemical analysis.—Two samples were obtained in this mine for analysis. Sample A was obtained at the point where section A was measured and sample B was obtained where section B was measured. These were obtained by making cuts from roof to floor, including all of the bed except the bony coal at the top. The samples thus obtained weighed about 25 or 30 pounds each.

These were crushed and quartered down until quart samples were obtained, which were then sealed in air-tight galvanized-iron cans and mailed to the chemical laboratory of the testing plant.

Character of car sample.—After inspection it was decided that run-of-mine coal represented the product of the mine better than any other grade, therefore for testing purposes the car was loaded with this coal. The car was shipped from the mine on September 9 and received at the testing plant October 10, 1904.

Equipment and use.—Mine No. 1 is one of two drift mines operated by D. Edwards & Son at this point. The entrance on the outcrop follows the dip of the coal, which is about 25° for about 800 feet. Side entries are turned off along the strike and from these the rooms are driven to the rise. The coal is delivered to the side entries from the face of the rooms by sheet-iron chutes. The coal is mined in two ways—by being shot off the solid and by being sheared on the rib. Most of the product of the mine, including even the slack, is sold for steam making.

INDIAN TERRITORY NO. 4.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 5, one-half mile north of Lehigh, Ind. T., on Missouri, Kansas and Texas Railway.

Sampler.—John W. Groves.

Coal bed.—The coal worked here is known locally as the Lehigh bed. It is believed by some to occupy a position a little higher in the section than the McAlester coal, which is one of the prominent beds of the southern Indian Territory coal field. The outcrop of the strata is continuous between this locality and McAlester, but on account of the disturbed condition of the rocks and the poorness of the exposures the coal beds have not been successfully traced. Lehigh and Coalgate are on the west side of the basin, and the coal dips generally to the east as low as 4°. Two sections of this coal bed are shown in fig. 4. Section A was measured in the eighth south entry in No. 5 slope and section B was measured in the third north entry in the south slope. In detail these sections are as follows:

Sections of coal bed in No. 5 mine, Western Coal and Mining Company, Lehigh, Ind. T.

Section A.	Ft.	in.	Section B.	Ft.	in.
Bony coal	0	4	Bony coal	0	4
Coal	4	0	Coal	4	10
Total	4	4	Total	5	2

Samples for chemical analysis.—Two samples were obtained in this mine for chemical analysis. Sample A was obtained from the place where section A was measured and sample B from the place where section B was measured. The face of the coal was cleaned of weathered coal and powder stain, and a cut was made from roof to floor exclusive of the layer of bony coal at the top. These samples were crushed and quartered down until about 1 quart was obtained from each. These were sealed in galvanized-iron cans and mailed to the chemical laboratory of the testing plant.

Character of car sample.—For general use this coal is screened over a 1-inch diamond-bar screen. For this reason lump, or coal which passed over the screen, was accepted for testing purposes. The coal was loaded in an ordinary gondola car, which was shipped from the mine September 27 and was received at the testing plant November 1, 1904.

Equipment and use.—The coal bed is reached by a shaft 240 feet deep. The mine is worked on the room-and-pillar system. Slopes are driven down the dips and inclines to the rise. Off of these the rooms are turned parallel to the strike. Rope haulage is installed on the slopes and planes, and mules are used elsewhere in the mine. The daily capacity is about 750 tons. Practically all of the coal mined is shipped to Texas, where it is used by several railroads for engine coal.

INDIAN TERRITORY No. 5.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 7, located at Lehigh, Ind. T., on Missouri, Kansas and Texas Railway.

Sampler.—John W. Groves.

Coal bed.—McAlester. (For sections see Indian Territory No. 4, p. 71.)

Character of car sample.—One of the great problems in this field is the better utilization of the slack coal. In preparing coal for the market it is passed through a three-fourths inch perforated revolving screen. That which passes over is considered as lump coal and that which passes through is regarded as slack. This slack is again screened through a one-half inch perforated screen and a grade of pea coal is saved. The slack passing through this screen is so dirty that it can not be marketed.

In order to attempt the solution of this problem slack and pea coal was sent to the testing plant. It was loaded in an ordinary open coal car, which was shipped from the mine September 27 and was received at the testing plant November 4, 1904.

Equipment. The plan and equipment of this mine is similar to that of mine No. 5, a description of which is given on page 71. Mine No. 7 is not quite so deep as mine No. 5, the coal in the former being reached at a depth of 109 feet.

INDIAN TERRITORY NO. 6.

Operator.—Southwestern Development Company, Parsons, Kans.

Mine.—Located at Coalgate, Ind. T., on the Missouri, Kansas and Texas Railway.

Sampler.—Shipped by owner.

Coal bed.—This coal is from the McAlester bed. It is the same coal bed that is worked at Lehigh, and the sections given in fig. 4 and described on page 71 are applicable to this locality.

Character of car sample.—This is in the same locality as the Lehigh mines, and the better utilization of waste slack is the most important problem of the day. Many have looked forward to the time when briquetting would be a commercial possibility and help to solve this problem. In order to have such tests made this car of slack was sent by the operator, and since it consisted of a waste product no supervision was needed. The car was shipped from the mine October 20 and received at the testing plant October 29, 1904.

RESULTS OF TESTS.

The steam tests show that the steam-producing qualities of Indian Territory coals are somewhat above the average of the coals tested. The average for the whole is 8.07 pounds of "equivalent evaporation from and at 212° F. per pound of dry coal," whereas these Territory coals show 8.64, 8.42, 8.17, and 7.53 pounds.

Two tests were made with these coals in the producer-gas plant, one on the Henryetta coal and the other on the Lehigh coal. It is probable that equally good results could have been obtained by using the other samples except those in which the sulphur was above 4 per cent. The calorific power of the gas obtained from these coals (159.15 and 161.1 B. T. U. per cubic foot) is above the average of those tested. The tables on pages 1109, 1120 show that only 1.83 and 1.43 pounds of dry coal were required to produce an electrical horsepower hour in the producer-gas plant, whereas 4.04 and 4.64 pounds of the same coals were required to produce the same result in the steam plant (pages 504, 528)—a gain in efficiency of 121 and 224 per cent. The figures given on page 872 show that 3.39 pounds of dry coal of the best West Virginia steam coal were required to produce an electrical horsepower hour; therefore, Territory coal used in the producer and gas engine shows a gain in efficiency over the best West Virginia coal used in the steam plant of 85 and 137 per cent.

Coking tests show that some of the Indian Territory coals will produce coke, not of a quality that can be used in an iron furnace, but good enough for lead smelting. Owing to the proximity of the Joplin district this property may be important.

Considerable effort was made to briquette the slack coal from the Coalgate region. The slack was extremely dirty, and, as shown on pages 1420–1421, 1440–1442, results were not altogether satisfactory, but it seems highly probable that commercial briquettes could be made from the slack coal from this field at a cost which would make the enterprise successful.

IOWA.

Iowa stands ninth in the list of coal-producing States in the Union and second in the list of such States west of the Mississippi River. In 1904 the output was 6,519,933 short tons.

The coal field is triangular in shape, its base being on the Iowa-Missouri State line and its apex near Fort Dodge, in Webster County. In general the coal-bearing rocks dip lightly to the southwest and extend entirely across the southwestern part of the State, but farther north they are concealed by Cretaceous sediment that has been laid down over them.

The coal-bearing rocks are divided into two groups—Des Moines above and Missourian below. The latter contains most of the important coal beds of the State. The coal beds appear to be extremely irregular in thickness and occurrence and for this reason it has not been found possible to correlate them. They are generally known by local names.

The coal tested came from the Missourian measures in Wapello, Marion, Polk, Appanoose, and Lucas counties.

Iowa No. 1.

Operator.—Anchor Coal Company, Ottumwa, Iowa.

Mine.—Mine No. 2, located at Laddsdale, Wapello County, Iowa, on Chicago, Rock Island and Pacific Railroad.

Sampler.—John W. Groves.

Coal bed.—In Wapello County the coal beds lie at no great depth below the surface. The middle bed in this mine is found at a depth of 58 feet, and what is called the third seam at a depth of 70 feet. The coal beds vary greatly in thickness in this region, but in the majority of places in which they are now worked they range from 3 to 5½ feet.

Two sections were measured on each bed and the variations are shown in fig. 5. The detailed sections are as follows:

Sections of coal bed in mine No. 2, Anchor Coal Company, Laddsdale, Iowa.

Middle bed.						Third bed.					
Section A.			Section C.			Section B.			Section D.		
	Ft.	in.		Ft.	in.		Ft.	in.		Ft.	in.
Coal	2	11	Coal	3	10	Coal	2	3	Coal	4	5

Samples for chemical analysis.—Two samples for chemical analysis were obtained in this mine. Sample A is from the middle seam and sample B is from the third seam. These samples were taken at the points where sections A and B, noted above, were measured. The samples were obtained in the usual manner by making cuts across the face of the coal from roof to floor, so as to obtain coal from all parts of the bed. The samples were then crushed and quartered down until about a quart of crushed coal remained of each sample. The samples were then packed in air-tight galvanized-iron cans and mailed to the laboratory at the testing plant.

Character of car sample.—Two grades of coal were loaded in the car for testing. In one end of the car was placed coal that had been passed over a 1¼-inch screen and in the opposite end of the car was loaded the material that had passed through the same screen. These grades together were in the proper proportion to constitute run-of-mine coal. This coal is all from the middle bed. The lower bed is not developed sufficiently to furnish much coal. The coal was loaded in an open coal car, which was shipped on October 17 and was received at the testing plant November 1, 1904.

Equipment and use.—The shaft at mine No. 2 cuts two beds of coal, the upper bed at a depth of 58 feet and the lower bed at a depth of 70 feet. The mine is comparatively new and at present commercial operations are limited to the upper bed. Mining is done on the room-and-pillar system. The coal is shot off the solid and hauled to the foot of the shaft by mules. The output of the mine at the time the sample was taken was only 30 tons a day, but as the workings are extended this will naturally increase, and it is expected that the mine will produce about 300 tons a day in the near future.

Most of the coal is taken by the railroads in the vicinity for engine coal, and the slack finds a market for steam purposes.

IOWA No. 2.

Operator.—Mammoth Vein Coal Company, Hamilton, Iowa.

Mine.—Mine No. 5, located in Liberty Township, Marion County, Iowa, on the Wabash Railroad.

Sampler.—John W. Groves.

Coal bed.—There are at least six well-defined coal beds in Marion County. These are nearly all well exposed in the bluffs of the Des Moines River. The coal beds of this county are among the most extensive of central Iowa. The seam worked in No. 5 mine is known locally as the Big Vein. The thickness and character of the bed are shown graphically in fig. 5, and also by detailed sections A and B. Section A was measured in the fifth west entry on the south side of the mine and section B was measured in the third west entry on the south side of the mine. The sections are as follows:

Sections of coal bed in mine No. 5, Mammoth Vein Coal Company, Marion County, Iowa.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	2	11	Coal	1	3
Sulphur and shale	0	1	Sulphur	0	2
Coal	1	3	Coal	3	11
Sulphur and shale	0	6			
Coal	2	6			
Total	7	3	Total	5	4

Samples for chemical analysis.—Two samples were cut in this mine for analysis. Sample A was obtained from the place where section A was measured and sample B from the place where section B was measured. These samples were obtained by making cuts from roof to floor, exclusive of the large partings, which are thrown out by the miner in loading the coal. These samples were carefully crushed and quartered down to about quart size and mailed to the chemical laboratory at the testing plant in air-tight galvanized-iron cans.

Character of car sample.—The car for testing purposes was loaded with run-of-mine coal. Many large sulphur balls are found in this coal, but these were mostly picked out in loading the coal. The coal was loaded in a gondola car, which was shipped from the mine October 23 and received at the testing plant November 23, 1904.

Equipment and use.—The coal is reached by a shaft at a depth of 45 feet. Where the coal is removed, the overlying strata cracks to the surface, giving considerable trouble from water during a wet season. The mine is worked on the room-and-pillar system, and the coal is hauled to the foot of the shaft by mules. The coal is mined by being shot off the solid. With the exception of the slack coal, which constitutes a small percentage, the entire production of the mine is used by railroads for locomotive fuel, the slack being sold for steam purposes. The daily capacity of the mine is 1,100 tons of run-of-mine coal, and an average daily output of 825 tons is maintained.

IOWA NO. 3.

Operator.—Gibson Coal Mining Company, Des Moines, Iowa.

Mine.—Mine No. 4, located near Altoona, Polk County, Iowa, on the Chicago, Rock Island and Pacific Railroad.

Sampler.—John W. Groves.

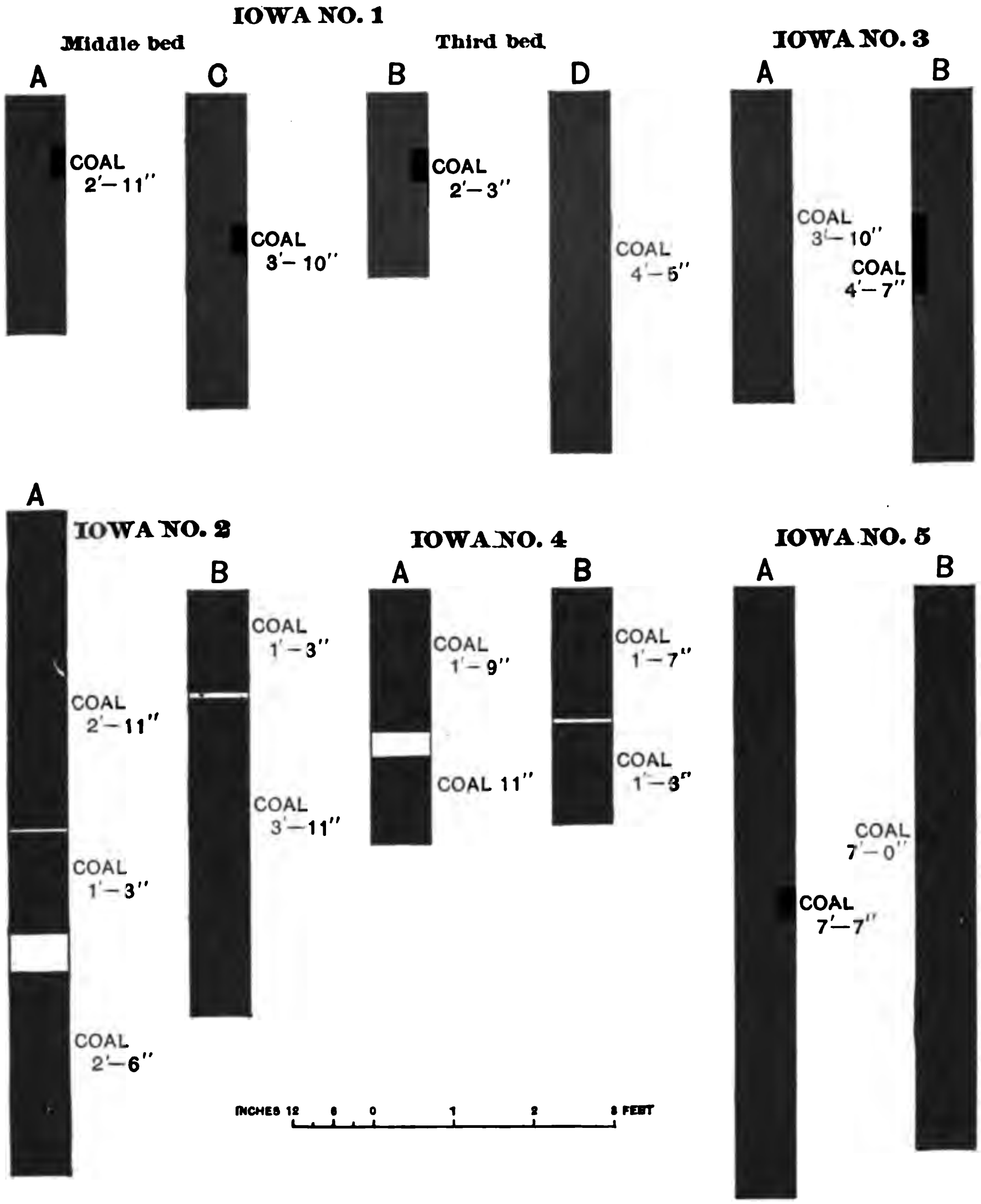

Fig. 5.—Sections of Iowa coal beds.

Coal bed.—Polk County has long been one of the most important coal-producing counties in the State. In this county three seams of coal are recognized. They are commonly called "first," "second," and "third" seams. These are the workable seams, and they have associated with them other beds that are not of workable thickness. Mine No. 4 is on the third seam. Two sections of this coal are shown graphically in fig. 5. Section A was measured in the ninth north entry and section B was measured in the main west entry. These sections are as follows:

Sections of coal bed in mine No. 4, Gibson Coal Mining Company, near Altoona, Iowa.

Section A.		Section B.	
	Ft. in.		*Ft. in.*
Coal	3 10	Coal	4 7

Samples for chemical analysis.—Two samples were cut from working faces of the mine to furnish material for chemical analysis. Sample A was obtained at the place where section A was measured and sample B at the place where section B was measured. These samples included all parts of the bed, and were obtained in the usual way, by cutting channels from roof to floor. The original bulk of the samples was reduced by crushing the pieces of coal to a uniform size and quartering down to about one-eighth of the original. These final samples contained about a quart and they were mailed in hermetically sealed galvanized-iron cans to the chemical laboratory.

Character of car sample.—The coal for testing was run into the car over a bar screen with five-eighths inch bars set 1⅝ inches apart. This constitutes lump coal and was selected, as run-of-mine coal is not shipped and the smaller sizes of coal and slack contain an abnormal amount of sulphur. The coal was loaded in an open coal car, which was shipped from the mine October 25 and received at the testing plant November 12, 1904.

Equipment and use.—The mine is reached by a shaft 196 feet deep, from which the workings extend in all directions, following the room-and-pillar method of mining. The entry coal is sheared from top to bottom, but in the rooms the coal is shot off the solid. Mule haulage is used exclusively for delivering the coal to the foot of the shaft. Most of this coal goes to the towns along the route of the Chicago, Rock Island and Pacific Railroad for domestic use; about 25 per cent is used for railroad-engine supply, and the remainder is sold to manufacturers for steam purposes. The daily capacity of the mine is 600 tons, and about 400 tons is the average daily output.

IOWA No. 4.

Operators.—Centerville Block Coal Company, Centerville, Iowa; Scandinavian Coal Company, Centerville, Iowa; Anchor Coal Company, Centerville, Iowa.

Mines.—These operators combined to send a car of coal from their district, and decided upon the Centerville Block Coal Company's mine No. 3 to supply the coal. The Centerville Block Coal Company operates 6 mines, the Scandinavian Coal Company 2 mines, and the Anchor Coal Company 3 mines, making a total of 11 mines for the district. Mine No. 3 of the Centerville Block Coal Company is located at Centerville, Appanoose County, Iowa, and is served by the Chicago, Burlington and Quincy; Chicago, Rock Island and Pacific; Iowa Central; and Chicago, Milwaukee and St. Paul railways.

Sampler.—John W. Groves.

Coal bed.—In the Appanoose County district the coal bed which is being mined has a wide geographical extent, covering nearly all of Appanoose County and parts of the adjoining counties of Iowa and Missouri. In the reports of the Iowa Geological Survey this coal bed is called the Mystic coal. At Centerville it is found at a depth of 125 feet, rising gradually to the north and east. At the mine from which the sample was obtained the coal is reached at a depth of 110 feet. Sections of the coal bed are shown graphically in fig. 5. Section A was measured in the first room off the sixth east entry, and section B in the first room off the sixth east entry off the main south entry. The sections are as follows:

Sections of coal bed in mine No. 3, Centerville Block Coal Company, Centerville, Iowa.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	1	9	Coal	1	7
Fire clay	0	4	Fire clay	0	1
Coal	0	11	Coal	1	3
Total	3	0	Total	2	11

Samples for chemical analysis.—Two samples were obtained in this mine for chemical analysis. Sample A was obtained at the place where section A was measured and sample B at the place where section B was measured. The samples were obtained by making a cut from roof to floor, including everything except the fire-clay parting. These samples were crushed and quartered down to about one-eighth their original bulk and mailed to the chemical laboratory at the testing plant in sealed metal cylinders.

Character of car sample.—The coal shipped for testing consisted of about 35 tons of lump and about 4 tons of fine coal. The lump coal was that which passed over a bar screen with $1\frac{3}{8}$-inch spaces, and the fine coal was that which passed through this screen. The slack, which was not included in the carload, was screened off through a five-eighths inch screen. The coal was loaded in a gondola car and shipped from the mine October 28 and was received at the testing plant November 14, 1904.

Equipment and use.—Mine No. 3 has an average daily output of 300 tons of coal. The shaft is 111 feet deep and the mine is worked on the room-and-pillar system. The coal is undercut, sheared on the sides, and wedged down. Where machines are used the coal is undercut by chain machines, and sheared on the sides with pick machines. About 35 per cent of the coal is cut by machine and the rest is mined by hand. The amount of coal mined by machine in the mines of the operators supplying the sample is 20 per cent of the total output. In mine No. 3 mule haulage and rope haulage are both used.

The daily output of the three companies averages about 900 tons, about half of which goes for steam purposes, and half for domestic use. Seventy-five per cent of the coal used for steam purposes goes to railroads for engine coal, and 25 per cent goes to manufacturers. The coal is marketed in the vicinity of Centerville as well as in near-by territory in adjacent States.

IOWA NO. 5.

Operator.—Inland Fuel Company, Chariton, Lucas County, Iowa.

Mine.—Inland No. 1, located in secs. 4, 5, 8, and 9, T. 72 N., R. 21 W., fifth principal meridian. At present the mine has no railroad connection.

Sampler.—John W. Groves.

Coal bed.—Two general coal horizons have been recognized in Lucas County, one near the surface and the other about 250 feet below. The Inland Fuel Company is working on a coal bed at the lower horizon, and reaches the coal by a shaft 250 feet deep.

The thickness of the coal bed, as determined by four measured sections, is 7 feet 4 inches, 7 feet 9 inches, 7 feet 7 inches, and 7 feet. Two of these sections are shown in fig. 5. The bed is irregular, being disturbed to some extent by horsebacks. The thick coal lies in local basins or swamps, and therefore does not extend for a great distance. The roof consists of black shale and the floor of about 3 inches of shale overlying sandy fire clay.

Samples for chemical analysis.—Two samples were taken in this mine for chemical analysis. Sample A was obtained in room 33, off the second north entry, and sample B was obtained in room 8, off the first east entry on the south side. They were obtained by making cuts across clean faces of the coal bed, from roof to floor. The coal so obtained was pulverized and quartered down until two quart samples were obtained, which were placed in galvanized-iron cans, sealed air-tight, and mailed to the chemical laboratory for analysis.

Character of car sample.—The carload sample for testing purposes consisted of run-of-mine coal. As the mine has recently been opened it has no railroad connection, and the coal had to be hauled 6 miles in wagons. The rehandling probably produced considerable slack, but since all coal was crushed at the plant before tests were made, this probably had little effect. The coal was loaded in a gondola car which was shipped from the mine October 31 and was received at the testing plant November 10, 1904.

Equipment.—The mine has been opened so recently that its equipment is not yet perfected. It is located 6 miles from the Chicago, Burlington and Quincy Railway, and is to be connected with that line by a spur.

Considerable prospecting has been done in advance of development so as to insure a good body of coal. The indications are that in the near future this will develop into a large mine.

SPECIAL SAMPLES OF IOWA COALS.

Two samples for chemical analysis were cut in mine No. 6 of the Smoky Hollow Coal Company, Avery, Iowa. This mine is operating in what is known as the third seam. The samples were obtained by making a cut from roof to floor and the analyses are given on page 270 under sample numbers 1288 and 1290. The sampling was done by Mr. John W. Groves on October 20, 1904.

RESULTS OF TESTS.

The Iowa coals tested contain high percentages of moisture, ash, and sulphur. These constituents add little or nothing to the calorific value of a coal, and as a result the Iowa coals take low rank. This is shown on pages 529–576, in the results of steam tests, where the equivalent evaporation from and at 212° is given as ranging from 7.02 to 7.50 pounds per pound of dry coal.

No thorough experiments were made on washing Iowa coals, but small lots of each sample were washed preparatory to making a test of their coking qualities. In all cases the results showed a notable reduction of ash and of sulphur, and it seemed probable that washing could be done to advantage in many parts of the Iowa field.

Coking tests were made on all samples of Iowa coals, but with indifferent success. In some cases no coke was produced; in others coke of fair quality was made. In all cases the coke was high in sulphur, which, of course, would preclude its use in an iron furnace, but it might be used in other ways.

No gas-producer tests were made during the regular work on Iowa coal, but later a run was made on the coal from Marion County. The test was not entirely satisfactory, as the quality of the gas varied greatly from time to time, but no clinkers formed in the producer, and it is probable that better results could be obtained on a second trial of this coal. Its high percentage of sulphur was a detriment, but it is probable that this can be eliminated with more careful work.

The figures on page 1130 show that to produce 1 electrical horsepower hour with this coal in the producer required 1.73 pounds of dry coal, whereas under the steam boiler (page 495) it required 4.95 pounds to produce the same result, a gain in efficiency for the producer of 186 per cent. As this coal ran nearly 17 per cent of ash in the car sample, the great advantage of using it in the producer plant will be apparent, and these results seem to open the way to the much better utilization of these low-grade Iowa coals.

KANSAS.

Kansas stands tenth in the list of coal-producing States, according to the report on the mineral resources of the United States for 1904. Its output in that year was 6,333,307 short tons. Coal mining is largely limited to four counties, of which Crawford and Cherokee, in the southeast corner of the State, are decidedly the largest producers. Leavenworth and Osage counties are very much less important than the counties just mentioned, but they also produce considerable coal.

There are two principal horizons from which coal is obtained. The most valuable of these occurs near the base of the coal-bearing rocks in what is usually known as the Cherokee shale. This bed of shale has a thickness of from 400 to 500 feet, and the most important coal bed occurs near the middle of the formation. The coal is known as the Weir-Pittsburg or Cherokee, and it is extensively mined in the vicinity of Pittsburg, in Cherokee County. The samples obtained at West Mineral, Scammon, Fleming, and Yale are from this bed.

In Leavenworth County the surface rocks belong to the upper part of the coal-bearing group, but coal beds in the Cherokee shale are reached by deep shafts. The sample from Atchison is probably from this horizon, as it required a shaft 1,150 feet in depth to reach the coal.

The coal bed worked in Osage County shows in outcrop in the eastern part of the county, and hence it occurs at a higher horizon than the Cherokee shale.

Coal beds are known still higher in the series, but generally the quality of the coal is not so good as the lower beds, and they are thin and irregular. For these reasons they have not been extensively developed.

KANSAS No. 1.

Operator.—Western Coal and Mining Company, St. Louis, Mo.

Mine.—Mine No. 10, located at Fleming, Crawford County, Kans., on the Missouri Pacific Railway.

Samplers.—John W. Groves and J. Shober Burrows.

Coal beds.—The only important coal beds in this vicinity are in the Weir-Pittsburg group. This group consists of two beds, known as the upper and lower beds. The coal being mined at Fleming is the lower Weir-Pittsburg. The outcrops of these beds form an irregular line extending northeast and southwest by way of Stippleville, Scammon, Weir City, Pittsburg, and other cities to the northeast. The lower bed is the thicker and is the one most extensively worked.

The thickness of this coal bed is shown in fig. 6 by two sections measured in this mine.

Sections of coal bed in mine No. 10, Western Coal and Mining Company, Fleming, Kans.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	3	5½	Coal	3	3

Samples for chemical analysis.—At two widely separated points in the mine samples were collected for chemical analysis. These samples were obtained by making cuts across working faces from roof to floor. The material obtained in this way amounted to 25 pounds per sample. Each sample was crushed very fine and quartered down to about 1 quart, which was placed in a galvanized-iron cylinder and mailed to the chemical laboratory for analysis.

Character of car sample.—The coal selected for testing purposes was run-of-mine coal. It was of good appearance and very free from shale and sulphur. It consisted of a fairly large proportion of lump coal and only a little slack. The coal was loaded in an ordinary open coal car, which was shipped from the mine August 23 and received at the testing plant September 9, 1904.

Equipment and use.—The Western Coal and Mining Company operates a number of mines in this vicinity, all of which are very similar in equipment and method of working. The mine is reached by a shaft 102 feet deep, which contains two self-dumping cages. The mine is worked by the room-and-pillar method, and hauling is done by mules. About 2 feet of brushing is necessary along the main entries, but this is not difficult, as the coal is overlain by a stratum of soft shale. The coal is rather tenacious in character, and is shot from the solid, according to the practice followed in the entire region. It is used mostly for steam purposes, a large amount going to the Missouri Pacific Railway for engine coal. The output of this mine is about 350 tons a day.

Kansas No. 2.

[illegible] Western Coal and Mining Company, St. Louis, Mo.

[illegible] Mine No. 11, located at Yale, Crawford County, Kans., on the Missouri Pacific Railway.

[illegible] J. Shelton Burrows.

[illegible] The coal worked here is the same bed from which sample Kansas No. [illegible] was obtained, namely, lower Weir-Pittsburg. This coal is developed [illegible] as at Fleming, but is somewhat different in character, containing two [illegible] persistent bands of sulphurous shale, dividing the bed into three benches of [illegible] thickness. These are shown graphically in fig. [illegible] and also in the following sections, which were measured at points some distance apart in the mine.

[illegible] Western Coal and Mining Company, Yale, Kans.

[illegible]		[illegible]	
	Ft. in.		Ft. in.
[illegible]	[illegible]	Coal	[illegible]
[illegible]	[illegible]	Sulphur	[illegible]
[illegible]	[illegible]	Coal	[illegible]
[illegible]	[illegible]	Sulphur	[illegible]
[illegible]		Coal	[illegible]
[illegible]	[illegible]	Total	[illegible]

[illegible] samples for [illegible] analysis were [illegible] making a [illegible]

[illegible]

[illegible]

and west and similar entries paralleling this one on either side. These are connected by cross cuts at right angles to the main entries. From these cross entries the rooms are turned off. Most of the coal is used for steam purposes and finds a ready market, about 550 tons being mined daily.

KANSAS NO. 3.

Operator.—Southern Coal and Mercantile Company, Scammon, Cherokee County, Kans.

Mine.—Mine No. 9, located one-fourth mile west of depot at Scammon, on Frisco Railroad.

Samplers.—Marius R. Campbell and J. Shober Burrows.

Coal bed.—The Weir-Pittsburg lower bed is worked in the No. 9 mine. It lies from 80 to 100 feet below the surface at Scammon. The coal outcrops a short distance south of the mine, limiting the development in that direction. In some parts of this district the coal is very thin, but this is a local condition and not of infrequent occurrence throughout the Cherokee County field. The coal is of good quality, but somewhat pyritiferous. The pyrite, however, occurs in lenses and can be separated from the coal in mining. Two sections of this coal are shown in fig. 6. Section A was measured at a working face 500 feet north of the shaft, and section B was measured at a working face 600 feet south of the shaft. At each place the coal bed measured 4 feet in thickness.

Samples for chemical analysis.—Two samples were obtained in the mine for chemical analysis. Sample A was obtained at the place where section A was measured, and sample B was obtained at the place where section B was measured. These samples were obtained by making a cut from roof to floor, after stripping off the loose and weathered coal. About 25 pounds of coal per sample was obtained. These large samples were crushed to a uniform size, quartered down to about 1 quart each, and mailed in air-tight galvanized-iron cans to the chemical laboratory at the testing plant.

Character of car sample.—A box car was loaded with run-of-mine coal for testing purposes. The mine had been idle for some time prior to the loading of the car, and for this reason the coal was stained and probably not of so good quality as the mine will produce when working in fresh coal. The larger pieces of pyrite were carefully picked out, and the car was sealed for shipment to the testing plant. It was shipped August 29 and received at the testing plant September 4, 1904.

Equipment and use.—The mine is operated in precisely the same manner as the others in the Cherokee field—by mule haulage, the coal being shot off the solid. A large amount of the product is screened. The room-and-pillar system of working is employed. About 250 to 300 tons are produced here daily, the lump coal finding a market in the towns of the region and on the railroads, and the slack coal going to the Kansas City packing houses.

KANSAS NO. 4.

Operator.—The Atchison Coal Mining Company, Atchison, Kans.

Mine.—Atchison mine, one-half mile below Atchison, Atchison County, Kans., on the Missouri Pacific Railway.

Sampler.—Shipped by operator.

Coal bed.—This is a new mine, opened very recently. The coal is reached by a shaft 1,150 feet deep, and it undoubtedly belongs in the Cherokee shale. According to Prof. Erasmus Haworth, State geologist, the coal bed has a thickness of from 3 feet 2 inches to 3 feet 6 inches. (See fig. 6.)

Character of car sample.—Owing to a misunderstanding this sample was shipped to the testing plant by the operator, without the personal supervision of an agent of the testing plant. The representative character of the coal is vouched for by Professor Haworth. The car contained lump coal, and the analyses are of coal obtained from this car, as no mine samples were available. The coal to be tested was loaded in an open coal car, which was shipped from the mine on October 29 and received at the testing plant November 14, 1904.

KANSAS NO. 5.

Operator.—Southwestern Development Company, Parsons, Kans.

Mine.—Mine No. 11, located at West Mineral, Cherokee County, Kans., on Missouri, Kansas and Texas Railway.

Sampler.—Marius R. Campbell.

Coal bed.—One of the Weir-Pittsburg coals is being worked at this point at a depth of 174 feet. The coal is very regular, and is of uniform thickness throughout, but "horsebacks" are numerous, rendering some of it worthless. Two sections, shown in fig. 6, were carefully measured in this mine. Section A was measured in the main east entry, at a point about 900 feet from the foot of the shaft, and section B was measured in the main west entry, about 540 feet from the foot of the shaft.

Sections of coal bed in mine No. 11, Southwestern Development Company, West Mineral, Kans.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	3	5¾	Coal	3	5

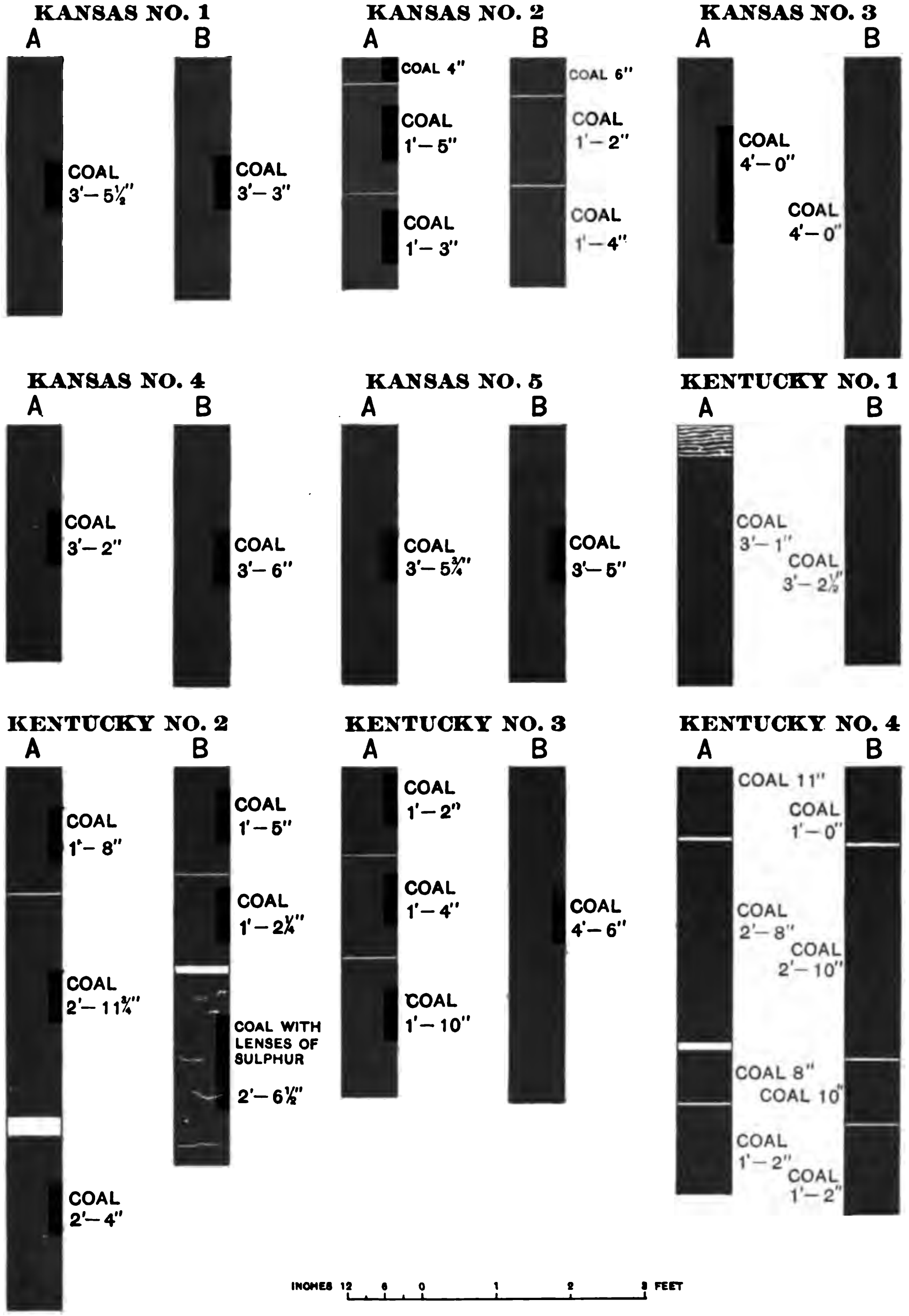

FIG. 6.—Sections of Kansas and Kentucky coal beds.

Samples for chemical analysis.—Two samples of this coal were taken from the mine for chemical analysis. The bed of coal being quite free from partings, all that was necessary to secure an average sample was to cut from some working face a complete section of coal from roof to floor. The samples were obtained at the same point that the sections were measured, sample A corresponding to section A, and sample B to section B. About 25 pounds of coal were obtained from these cuts for each sample. This material was taken to the surface and carefully crushed and quartered down to about 5 pounds per sample. These were mailed in air-tight galvanized-iron cans to the chemical laboratory at the testing plant.

Character of car sample.—Lump and nut, or engine coal, was the grade loaded for testing. This grade is composed of all that passes over a five-eighths inch perforated screen. Two men were employed to pick the slate from the car as the coal was loaded, and this practice is followed with all cars loaded for commercial purposes. The coal was loaded in an open coal car, which was shipped from the mine November 10 and received at the testing plant November 25, 1904.

RESULTS OF TESTS.

The steam tests made on samples of Kansas coal received at the testing plant show that it is a fairly good coal for this purpose, running somewhat better than the coals from adjoining States, except those from Indian Territory, to which it is about equal.

Most of the samples were tested for their coking quality, but the results were not satisfactory. Some coke was produced, but the tests can in no way be considered as indicating a coking coal.

No sample from Kansas was tested in the gas producer during the regular season of work at the testing plant, but later a run was made on coal from Cherokee County which was fairly satisfactory for about thirteen hours until it was interrupted by a short circuit in the rheostat.

The figures on page 1139 show that 1.62 pounds of dry coal were required in the producer plant to generate 1 electrical horsepower hour, whereas under the steam boilers (page 608) 3.93 pounds were required to produce the same result, a gain in efficiency for the producer of 143 per cent.

KENTUCKY.

According to Mineral Resources of the United States for 1904, Kentucky stands seventh in the list of coal-producing States, its output in that year being 7,566,482 short tons.

This State includes parts of two of the great coal fields of the United States—the Appalachian field on the east and the eastern interior field on the west. The importance of these two fields, so far as this State is concerned, is about equal. In 1903 the coal production of western Kentucky was 4,379,060 short tons and the production of the eastern field was 3,158,972 short tons.

The eastern coal field of Kentucky includes most of the central part of the Appalachian field. It contains a number of coal beds of great importance. In the small space available it is impossible to give an adequate idea of the various coal beds and their relations. Only one sample of coal was received from this field. It came from a mine on Straight Creek in the vicinity of Pineville. On account of the great fault at the northwestern base of Pine Mountain, the position of this bed has not been well determined, but it is correlated by some with the Jellico coal, found farther southwest.

A car was also loaded with Jellico coal, furnished by the Main Jellico Mountain Coal Company, of Kensee, Ky., but while in transit the coal was appropriated by the railroad company, and hence failed to reach the testing plant. Mine samples of this coal were obtained, however, and their analyses can be found on page 270.

The western district of Kentucky is a part of the eastern interior coal field, which covers most of Illinois and the southwestern part of Indiana. To the south it extends about halfway across the State of Kentucky. Three samples were received from this district, two coming from Earlington, Hopkins County, and one from Wheatcroft, Webster County. There are two important coal beds in this part of the State, known as coal No. 9 and coal No. 11. Both beds are worked at Earlington and a sample was sent from each. At Wheatcroft only coal No. 11 is worked and the sample is from that bed.

KENTUCKY No. 1.

Operator.—National Coal and Iron Company, Louisville, Ky.

Mine.—Straight Creek No. 2, located at Straight Creek, Bell County, Ky., on the Louisville and Nashville Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal worked in this mine is known locally as the Straight Creek bed. The geology of this part of Bell County is rather complicated, and the coal beds of the region have not been definitely correlated with any of the well-known beds of Kentucky or Tennessee. The Straight Creek bed shows in outcrop along this stream and is worked from a drift opening. Two sections, shown in fig. 6, were measured in this mine. Section A was measured at the face of the main entry and section B in room 76 off the main entry. The sections are as follows:

Sections of coal bed in Straight Creek mine No. 2, National Coal and Iron Company, Straight Creek, Ky.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal (shaly)	0	4½	Clayey shale.		
Coal (clean)	3	1	Coal (clean)	3	2½

Samples for chemical analysis.—Two samples for chemical analysis were taken in this mine, one at the point where section A was measured and one at the point where section B was measured. In obtaining these samples the usual method was followed; the loose and weathered coal was first removed and then a cut was made across the face of the coal bed from roof to floor. The material thus obtained was crushed and quartered down according to the methods generally employed in such work until quart samples were obtained. These were placed in galvanized-iron cylinders, sealed air tight with screw top and tire tape, and mailed to the chemical laboratory for analysis.

Character of car sample.—The car of coal for testing purposes was loaded with run-of-mine coal. The tipple is equipped with bar screens, and no provision is made for shipping run-of-mine coal, consequently the coal as it came from the mine was dumped into a separate chute which was so high and steep that the coal was badly shattered in striking the trap at the bottom.

On account of these conditions of loading, the car contained more fine coal than would be found in run-of-mine coal loaded by proper means. The coal was loaded in an ordinary open coal car, which was shipped from the mine October 25 and received at the testing plant November 23, 1904.

Equipment and use.—The National Coal and Iron Company operates two mines at Straight Creek. Mine No. 2 has an output of 600 tons a day and is operated on the room-and-pillar system. About 75 per cent of the coal is cut by air machines, and it is all hauled to the tipple by mules.

This coal is used for a variety of purposes, which, in the order of amounts consumed, may be classed as follows: (1) Domestic use; (2) coke making; (3) manufacturing; (4) gas making; and (5) for engine coal by railroads. The principal distributing points for this coal are Louisville, Ky., Indianapolis, Ind., and Chicago, Ill.

KENTUCKY No. 2.

Operator.—St. Bernard Mining Company, Earlington, Hopkins County, Ky.

Mine.—Mine No. 11, located at Earlington, Hopkins County, on the Louisville and Nashville Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal worked at this mine is that which is called in the State reports coal No. 11. It is one of the two important workable coals of this part of Kentucky, the other being bed No. 9. Bed No. 11 is much more irregular than No. 9, and at most of the mines it has a thickness of 6 feet or over. The bed is reported as always having a clay parting from one-fourth inch to 2 or 3 inches thick, and it is much disturbed by rolls, clay slips, etc. As a rule, it is not under deep cover, usually outcropping at the surface and extending to depths of less than 100 feet.

Two sections of this coal which were measured in mine No. 11 are shown in fig. 6. Section A was measured in room 10, off the third west entry, and section B in room 15, off the fourth west entry.

Sections of coal bed in mine No. 11, St. Bernard Mining Company, Earlington, Ky.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	1	8	Coal	1	5
Sulphur	0	¼	Sulphur	0	¼
Coal	2	11¾	Coal	1	2¼
Fire clay	0	3¼	Fire clay	0	2
Coal[a]	2	4	Coal[a]	2	6½
Total	7	3¼	Total	5	4

[a] This bench of coal contains irregular streaks and knife blades of sulphur.

Samples for chemical analysis.—At each point where a section was measured a sample for chemical analysis was obtained in the following manner. The face of the room having been cleared of all loose and weathered coal, a cut was made from roof to floor, including everything except the fire-clay parting. About 25 pounds of material was obtained for each sample. This material, owing to the way it was cut, was representative of every part of the bed at that point. It was taken out of the mine, crushed and quartered down until a quart sample was obtained, which was sealed in air-tight galvanized-iron cans and mailed to the chemical laboratory for analysis.

Character of car sample.—The car of coal for testing purposes was loaded with 75 per cent lump and nut coal (over seven-eighths inch screen) and 25 per cent pea and slack coal (through seven-eighths inch screen). In the ordinary working of the mine these grades are produced in the proportion of 3 to 1; therefore the car as loaded really contained run-of-mine coal. The coal was screened at the mine only to facilitate its distribution at the plant for special tests requiring screened coal. The coal was loaded in a gondola car, which was shipped from the mine November 3 and received at the testing plant November 6, 1904.

Equipment and use.—Mine No. 11, of the St. Bernard Mining Company, is one of the oldest producers of the Hopkins County district. At the time the sample was shipped the entrance to this mine consisted of a shaft 60 feet deep, from the head of which the loads were hauled by steam locomotive through a long tunnel to the tipple, some distance away. This involved considerable expense, as the inside trips had to be broken up, the loads sent up the shaft singly, and again made up into trips on the surface for hauling to the tipple. In anticipation of abandoning this shaft and the old method of handling the output of the mine, the company has run an entry in on the outcrop and has planned to install electric haulage, doing away with the double handling of the cars and the steam locomotives. The underground workings are laid out on the room-and-pillar system, and the coal is all cut by air machines.

The capacity of mine No. 11 is 1,000 tons of coal a day, the larger part of which is used by the Louisville and Nashville Railroad for engine coal. The remainder goes to some of the Southern cities for factory use, and the slack is utilized in the production of coke at the mine.

In addition to the mine described above, the company operates a mine on the other coal bed at Barnsley, which is described under the sample called Kentucky No. 3.

KENTUCKY No. 3.

Operator.—St. Bernard Mining Company, Earlington, Hopkins County, Ky.

Mine.—Barnsley mine, Barnsley, Hopkins County, Ky., on Louisville and Nashville Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The workable coal of western Kentucky is confined mainly to two beds, designated in the reports of the State Geological Survey as Nos. 9 and 11. Of these No. 9 is the more persistent and furnishes by far the larger part of the output of this field. This bed has an average thickness of 5 feet, seldom varying more than 6 inches from the average. As a rule it is found at depths less than 200 feet. The Barnsley mine is working this coal from the outcrop.

The sections given below, and also shown in fig. 6, represent the character of the coal bed in this mine. Section A was measured at the face of the third west entry, and section B was measured in the newest break-through (November 2, 1904) between the third and fourth north entries.

Sections of coal bed in Barnsley mine, St. Bernard Mining Company, Barnsley, Ky.

Section A.	Ft. in.	Section B.	Ft. in.
Coal	1 2	Coal	4 6
Sulphur	Trace.		
Coal	1 4		
Sulphur	Trace.		
Coal	1 10		
Total	4 4	Total	4 6

In section A the sulphur partings are very thin bands of iron pyrite. They are not persistent, and where present do not always occupy the same positions relatively, as shown in the above section. They vary greatly in thickness.

Samples for chemical analysis.—At the points where sections A and B were measured samples for analysis were taken in the following manner: The face of the coal was first stripped of all loose and powder-burned coal and, after a bright surface had been reached, a straight groove was cut from roof to floor, furnishing about 25 pounds of coal per sample. Each sample was pulverized and quartered down to about quart size and mailed to the chemical laboratory in an air-tight galvanized-iron can.

Character of car sample.—The car for testing purposes was loaded with 20 tons of run-of-mine coal and 20 tons of lump and nut (over a seven-eighths inch shaker screen). This was done because there has been considerable discussion in this field as to the relative efficiencies of these grades of coal for steam purposes, and more especially for locomotive use. The coal was loaded in an open coal car, which was shipped from the mine November 16 and received at the testing plant November 19, 1904.

Equipment and use.—The Barnsley mine is another large producer of the St. Bernard Mining Company, having a daily capacity of 700 tons. As stated above, the opening is on the outcrop, and mules are used to haul the coal to the tipple. The mine is laid out on the double-entry system and the coal all mined by air-pick machines. The slack from this mine has been used for making coke, but most of the product is shipped to southern cities for domestic and factory consumption.

KENTUCKY No. 4.

Operator.—Wheatcroft Coal and Mining Company, Wheatcroft, Webster County, Ky.

Mine.—Wheatcroft shaft mine, Wheatcroft, Webster County.

Sampler.—J. Shober Burrows.

Coal bed.—The Wheatcroft shaft mine is on the No. 11 coal bed, which at this point lies from 40 to 60 feet below the surface. The bed is much broken up by partings of fire clay and sulphur, and has to be carefully mined to insure a fairly clean product. The two sections shown in fig. 6, and also given below, were measured in this mine. Section A was measured in room 8 off the west shaft entry and section B was measured at the face of the second west entry.

Sections of coal bed in shaft mine, Wheatcroft Coal and Mining Company, Wheatcroft, Ky.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	0	11	Coal	1	0
Fire clay	0	1	Fire clay	0	1
Coal	2	8	Coal	2	10
Fire clay	0	2	Fire clay	0	1
Coal	0	8	Coal	0	10
Sulphur	0	1	Sulphur	0	½
Coal	1	2	Coal	1	2
Total	5	9	Total	6	½

Samples for chemical analysis.—Two samples were taken from this mine for analysis, one from the place where section A was measured and the other from the place where section B was measured. In collecting these samples a cut was made directly across the face of the coal from roof to floor, exclusive of the partings discarded by the miner in loading the coal in the mine cars. In this way about 25 pounds of coal was obtained, which was crushed and quartered down until a sample of about 1 quart remained. This was packed in an air-tight galvanized-iron can and mailed to the chemical laboratory at the testing plant.

Character of car sample.—The car shipped from this mine contained run-of-mine coal. After the car had been loaded it was decided not to ship it, as the coal was being carelessly mined and contained an abnormal quantity of iron pyrite and fire clay, as well as pieces of shale from the roof of the mine. In loading the second car the force of slate pickers was augmented and the car was loaded very slowly, to facilitate the removal of the excess of foreign matter over an amount that might reasonably be expected to be found in a coal having several partings. Both cars were loaded the same day under the personal supervision of the sampler. The coal was loaded in a gondola car, which was shipped from the mine November 4 and received at the testing plant November 19, 1904.

Equipment and use.—The Wheatcroft mine is reached by a shaft 40 feet deep. The room-and-pillar method of mining is used, and electric haulage is installed. About 50 per cent of the coal is undercut by electric machines and the balance by hand. This mine has been in existence for about three years, and is modern in every detail. A small percentage of the coal is used by the Illinois Central Railroad and the balance is shipped to southern towns and ports for steam purposes.

SPECIAL SAMPLES OF KENTUCKY COALS.

Two samples for chemical analysis were cut in the mines of the Main Jellico Mountain Coal Company, at Kensee, Ky. Sample 1329 was taken in the new mine and 1330 in the old mine. They were obtained by making cuts from roof to floor in the usual manner, and the samples were sealed and sent to the chemical laboratory of the testing plant. The sampling was done by Mr. J. Shober Burrows on October 28, 1904.

RESULTS OF TESTS.

Tests made on the samples received at the testing plant show that Kentucky coal, from both eastern and western fields, is above the average in point of steam production; but they also show that the coal from the eastern field is in this respect several points ahead of that from the western field.

Only one test was made with Kentucky coal in the producer-gas plant, and this coal was from the western field. The result is satisfactory, although the percentage of sulphur in the coals of western Kentucky is very near the limit with the purifying apparatus in use. It is probable, however, that in the future this defect will be removed and coals carrying almost any percentage of sulphur can be used. The results given on page 978 show clearly the enormous gain in efficiency in the use of this coal in the producer plant and gas engine over its use in the steam plant. As shown on page 672, 4.22 pounds of dry coal were required in the steam plant to produce one electrical horsepower hour, whereas in the producer-gas plant only 1.91 pounds of the same dry coal were used in producing the same result. The gain in efficiency is 121 per cent. Not only is there a gain in efficiency over the same coal when used in the steam plant, but there is also a great gain over some of the best steam coals of the country when used in this way. For example, of the best steam coal tested 3.39 pounds of dry coal were required for the production of one electrical horsepower hour, against 1.91 pounds of dry Kentucky coal when used in the producer-gas plant.

Similar results could doubtless be obtained with the other samples of Kentucky coal, but in a general way the greatest gains in efficiency were made with relatively low-grade coals.

Coking tests show that these coals will all produce good coke, but the samples from the western part of the State are high in sulphur, and the coke made from them can not be used in iron smelting.

A few experiments seemed to indicate that it is possible to briquette all the Kentucky coals that were tested with a percentage of pitch so small that briquetting might be made commercially successful. The experiments made in briquetting coke breeze may be of particular interest to the coal operators of this State, because it shows a method of converting waste coke into a good substitute for anthracite coal, and while the tests were made with West Virginia coke there is no reason why coke made from Kentucky coal also may not give good results.

MISSOURI.

The coal field of Missouri embraces an area of about 23,000 square miles in the northwestern quarter of the State, but much of this is unproductive at the present time. The total output of the State in 1904 was 4,168,308 short tons of coal. The productive territory may be divided into three important districts, which classed according to their production are as follows: (1) Macon, Randolph, Adair, and Putnam counties; (2) Lafayette and Ray counties; and (3) Barton, Bates, and Vernon counties.

The first-mentioned district occupies a zone about two counties wide extending northward from Missouri River to the Iowa State line. In point of production it is the most important coal district in the State. In the testing work it was represented by two samples—one from Bevier, Macon County, and the other from Mendota, Putnam County.

The second district was not represented in the testing work. The third district was represented by only one sample, which came from Sprague, Bates County, but the district is also represented by four samples from the Pittsburg, Kansas, field, from the same coal bed that is mined in Vernon and Barton counties.

Besides the large fields mentioned above there are many other points of development within the main coal field of the State as well as in small outliers in the central part of the State. Most of the isolated deposits are in the nature of pockets in the underlying limestone, and although they may contain very thick beds of coal they are of little commercial value on account of their limited extent. The sample from near Barnett, Morgan County, was procured from a particularly thick pocket of this character.

MISSOURI No. 1.

Operator.—New Home Coal Company, Sprague, Mo.

Mine.—New Home mine, New Home, Bates County, on a branch line of the St. Louis and San Francisco Railroad.

Samplers.—J. Shober Burrows and Marius R. Campbell.

Coal bed.—The coal bed mined at New Home is a local deposit of small extent, consisting approximately of 600 acres of workable coal. It is generally supposed to be at the same horizon as the coal that has been mined for a number of years at Rich Hill, a few miles to the southeast.

The coal is very free from partings, as shown by two sections in fig. 7. Section A was measured at the face of room 18 off the first east entry and section B was measured at the bottom of the slope in the first east entry.

Sections of coal bed in mine of the New Home Coal Company, New Home, Mo.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	3	1	Coal	3	8
Sulphur	0	0½	Sulphur	0	1
Coal	1	3	Coal	1	6
Total	5	4½	Total	5	3

Samples for chemical analysis.—Two samples were obtained in this mine for chemical analysis in the customary manner, by stripping from a working face the loose and powder-burned coal and then cutting a section from roof to floor, exclusive of the partings thrown out by the miner. The material obtained in this manner amounted approximately to 25 or 30 pounds per sample. It was crushed and quartered down to 4 or 5 pounds to the sample and sent by mail to the laboratory in air-tight galvanized-iron cans. Sample A was obtained at the place where section A was measured and sample B was obtained at the place where section B was measured.

Character of car sample.—The car was loaded with run-of-mine coal for testing purposes. Owing to a drop of 20 feet from the apron of the screen to the car, the coal was badly broken, and, as a result, the car contained more than the usual amount of slack coal. The coal was loaded in an ordinary open coal car which was shipped from the mine on August 31, and received at the testing plant September 14, 1904.

Equipment and use.—The New Home mine is a new mine, which has been in operation only little more than a year. The coal is reached by a shaft 257 feet deep. The room-and-pillar method of mining is followed, with parallel entries running north and south. The coal in the north entry dips abruptly from the foot of the shaft at an angle of from 15° to 20°. This slope continues for about 200 feet and then the coal runs level. A stationary engine is used to haul the cars up this incline to the shaft level. At other points in the mine the coal is hauled by mules. There are no machines used in mining the coal, as it is shot from the solid. A bad roof and considerable gas has been the cause of rather slow development in this mine, but an excellent system of ventilation has been installed and the mine is in good shape to produce from 250 to 300 tons of coal a day. This coal is sold mostly for steam purposes. A large percentage of the product is used by the Frisco Railroad, and some is shipped to Kansas City for the general trade.

MISSOURI No. 2.

Operator.—Northwestern Coal and Mining Company, Kansas City, Mo.

Mine.—Mine No. 8, located 1 mile south of Bevier, Macon County, Mo., on the Chicago, Burlington and Quincy Railway.

Sampler.—John W. Groves.

Coal bed.—The coal bed worked in mine No. 8 is the Bevier coal. This bed has the widest distribution of all the Missouri coals, and from it the greatest part of the State's tonnage is derived. The seam spreads out over Macon, Linn, Chariton, Randolph, and parts of the adjoining counties, and varies in thickness from 4 to 6 feet. The three sections shown in fig. 7 were measured in this mine. Section A was measured in the first east entry on the north side, and section B was measured in the second west entry on the south side. The sections are as follows:

Sections of coal bed in mine No. 8, Northwestern Coal and Mining Company, Bevier, Mo.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	3	5	Coal	4	5
Shale	0	1½	Shale	0	3
Coal	1	0	Coal	0	10
Total	4	6½	Total	5	6

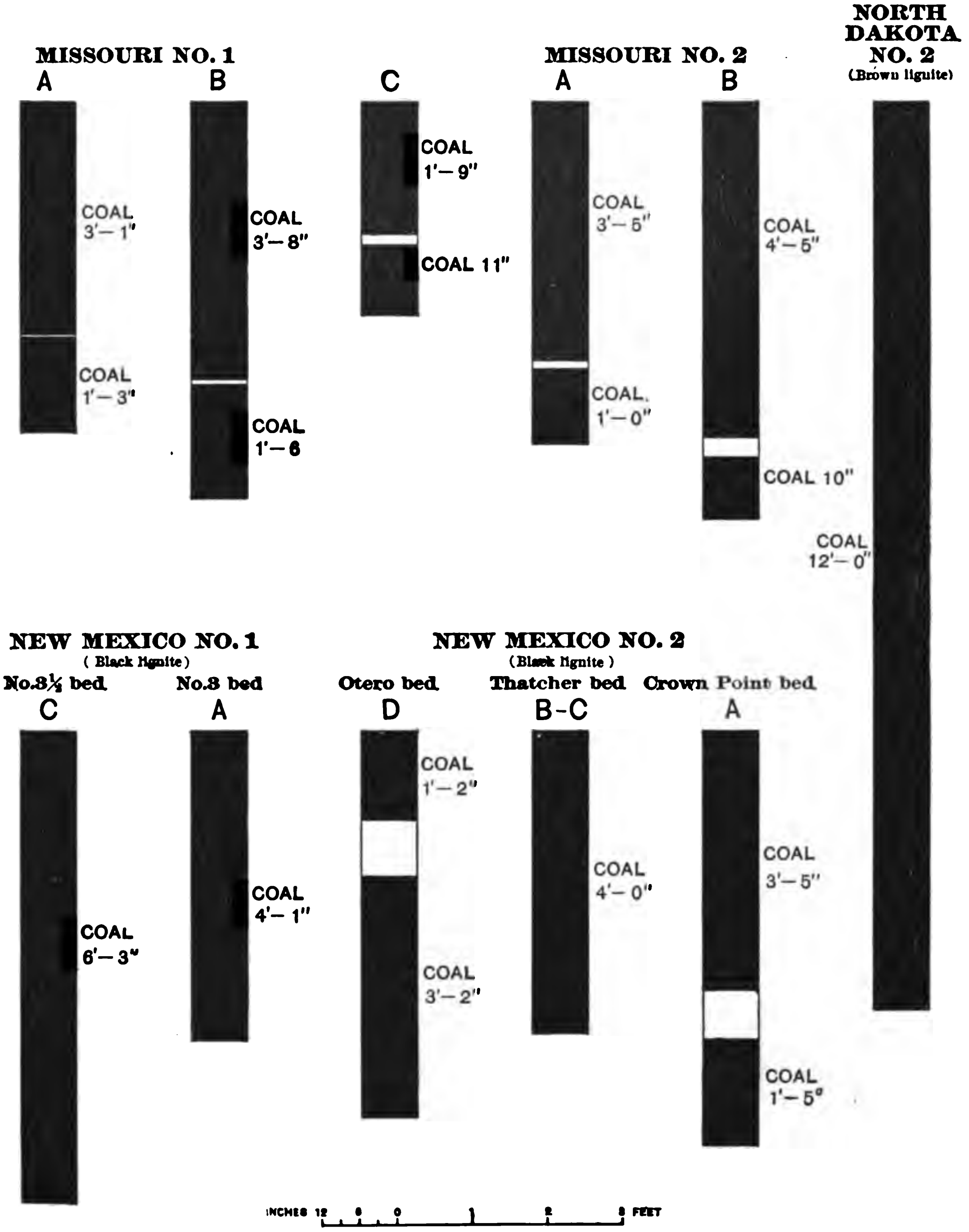

FIG. 7.—Sections of Missouri, New Mexico, and North Dakota coal beds.

Samples for chemical analysis.—Two samples for chemical analysis were sent to the laboratory from this mine. Sample A was obtained at the same place that section A was measured, and sample B from the place where section B was measured. These samples were obtained in the usual way by making a cut across a working face of coal, including all of the material cut through except partings of sufficient size to be separated by the miner in regular work. Each such cut furnished about 25 pounds of coal, which was then crushed and quartered down to about quart size. These samples were sealed in galvanized-iron cylinders and mailed to the chemical laboratory at the testing plant.

Character of car sample.—Run-of-mine coal was loaded for testing purposes, that being representative of the output of the mine. The coal was loaded in an open coal car, which was shipped from the mine October 10 and received at the testing plant October 22, 1904.

Equipment and use.—The coal is reached by a shaft 135 feet deep. It is worked by the double-entry room-and-pillar system, with mule haulage to the foot of the shaft. The coal is mined entirely by hand, being shot off the solid. The capacity of the mine with the present equipment is 1,000 tons, and an average daily output of 850 tons is maintained. The coal is used principally for steam making, the railroads using the largest amount of the output for locomotive coal. About 20 per cent goes for domestic or household use, and the balance, including the slack, is sold to manufacturing plants.

MISSOURI No. 3.

Operator.—Mendota Coal and Mining Company, Mendota, Mo.

Mine.—Mendota, Putnam County, Mo., on the Chicago, Burlington and Quincy Railway.

Sampler.—John W. Groves.

Coal bed.—This coal is largely known as the Mendota bed. It is the same as the Mystic coal which is so extensively worked across the State line in Appanoose County, Iowa. Only [illegible] coal was sent from this mine, and consequently the mine was not carefully examined and no measured sections were obtained. As reported by the State mine inspector, the coal in the mines of this company averages about 34 inches in thickness, including a clay band 2 inches thick running through the center of the seam.

Samples for chemical analysis.—No samples were taken in the mine for this purpose. The character of the coal is shown on page 237 by the chemical analysis of the coal from the car sample when it arrived at the testing plant.

Character of car sample.—The coal from this mine is screened over bar screens having an aperture of 1½ inches. Between 75 and 88 per cent of the product passes over the screen and is sold as lump coal; the remaining 12 to 25 per cent is screened in revolving screens having 1-inch and three-eighths-inch perforations. This gives three grades, nut (2½ per cent), pea (4½ per cent), and slack (5½ per cent).

The mine was not in operation at the time it was visited by Mr. Groves, but arrangements were made to obtain a car of slack for washing tests. Accordingly (as stated in a letter), the car was loaded by the operator with about 33 tons of screenings which passed through the 1¼-inch bar screen. The coal was shipped in an open car November 7 and was received at the testing plant November 30, 1904.

Equipment and use.—At the present time this company is operating three mines in the vicinity of Mendota, Putnam County, Mo., and two mines on the same coal bed in Appanoose County, Iowa.

The screenings from these mines are generally used for steam purposes, going to packing houses, elevators, electric-light plants, mills, etc. Some is used for burning ballast. The slack is very dirty and can be greatly improved by washing, as is shown on pages 721–736.

MISSOURI NO. 4.

Operator.—Morgan County Coal Company, St. Louis, Mo.

Mine.—This mine is not yet developed. It is located in sec. 6, T. 42 N., R. 15 W., or about 10 miles southeast of Versailles, Morgan County, Mo. It has no railroad connection.

Sampler.—John W. Groves.

Coal bed.—The company is preparing to operate this mine on one of the pockets of coal that are common in the central part of the State. The pocket is of unknown thickness, but is variously reported from 40 to 64 feet. The coal exposed at the present time is 14 feet thick, but the floor and roof are both in coal, so it affords no indication of the total thickness. It is probable that the pocket is of small extent, covering only a few acres.

Samples for chemical analysis.—Two samples were obtained from the left side of the pit for chemical analysis. The samples were pulverized and quartered down until each contained about 1 quart of coal, which was sealed in a galvanized-iron can and sent to the chemical laboratory of the testing plant.

Character of car sample.—The car was loaded with 16 tons of run-of-mine coal, the small size of the sample being due to the fact that the mine has not yet railroad connection and the coal had to be hauled to the railroad, several miles distant. The coal contains considerable sulphur and also veins of zinc ore. The coal was loaded in a box car, which was shipped from Bartlett November 18 and received at the testing plant November 22, 1904.

Equipment.—At the present time a country bank only is being operated at this place, but as soon as a spur is built from the Rock Island Railroad the coal company expects to begin operations with a steam shovel, first removing the cover of dirt, about 20 feet deep and then attacking the coal deposit in the same way.

SPECIAL SAMPLES OF MISSOURI COALS.

Two samples for chemical analysis were taken in the Summit mine of the Western Coal and Mining Company at Lexington, Mo. The coal bed has a thickness of from 20 to 22 inches and is mined by the long-wall system. The samples, numbered 1010 and 1011, were obtained by making cuts across the face of the coal. These samples were crushed and quartered down and sent to the laboratory in sealed cans. The sampling was done by Mr. J. Shober Burrows on August 17, 1904.

RESULTS OF TESTS.

The chemical tests made on samples of Missouri coals show that generally they contain heavy percentages of both ash and sulphur. The best coal in that respect is the one from Morgan County, which carries only about 5 per cent of ash. The sample marked Missouri No. 3 is particularly high in ash, but this was a car of slack sent for the express purpose of determining to what extent the ash and sulphur could be reduced by washing. The results given on pages 1464–1465 show that the ash can be greatly reduced and the sulphur content lowered by washing.

The steam tests given on pages 681–744 show that these coals are not high-grade steam coals. The best sample in this respect is the coal from Morgan County, which runs above the average of all the coals of the State tested for steam-raising properties. With the other samples the results are not very high, but in two cases the steaming value of the coal was greatly increased by washing.

Only one sample from this State was tried in the producer-gas plant. It yielded fair results, but the test was interrupted at the end of 4.33 hours by trouble with the gas engine, and consequently the results can not be depended upon as conclusive. The high percentage of sulphur may give some trouble in the gas engine, but this does not seem to be serious, and it is probable that some way will be found of purifying the gas to a greater extent than can be done at the present time.

The results obtained in the producer-gas plant show that 1.71 pounds of dry coal so used produced as much power as 4.93 pounds of the same coal burned under the steam boiler. Since the quantity of ash in a producer is of no material consequence unless clinkers are formed, it seems probable that dirty coals can be used in this way to great advantage.

NEW MEXICO.

At present New Mexico does not stand very high in the list of coal-producing States, being No. 20 in the list for 1904, with an output of 1,452,325 short tons. There are a number of somewhat widely separated coal fields in New Mexico, one of which, the Gallup-Durango field, is of large geographic extent and contains an immense amount of coal. The next field of importance is the Raton field, which is the southward extension of the Las Animas field of Colorado. Besides the large fields the Territory contains a number of small fields, being mostly local synclines of the coal-bearing rocks or faulted block.

The Gallup-Durango field is extensive, although it is but little known except in the vicinity of Gallup and along the northern boundary, where mining has been undertaken along the Denver and Rio Grande Railroad. The principal coal horizon occurs near the base of the Laramie formation, which is the uppermost member of the Cretaceous system. At Durango, Colo., workable coal beds occur in lower formations of the Cretaceous, but they are not known south of this margin of the field.

The samples tested were obtained at Gallup, N. Mex. At this place there are two coal-bearing horizons separated by about 400 feet of sandstone, clay, and shale beds. The upper group of coal beds are exploited at the Weaver mine, north of Gallup, and at Clarkville, 4 miles west of Gallup. The lower group is mined 2 miles east of Gallup.

The upper group consists of at least five seams of workable thickness. In descending order these are known as Nos. 1, 2, 4, 5, and 6. The coal beds are irregular in their occurrence, and at the Weaver mine, from which the sample called New Mexico No. 1 was obtained, a thick coal bed occurs a short distance below coal bed No. 3. This is regarded as an extra seam, and it is called coal bed No. 3½.

The lower group of coal beds consists of three distinct beds, all of which are mined at the Otero mine, 2 miles east of Gallup, where the sample marked New Mexico No. 2 was obtained. The uppermost bed is known as the Crown Point; the second bed, occurring 11 feet lower in the series, is known as the Thatcher bed, and the lowest, occurring 88 feet below the Thatcher, is known as the Otero bed.

NEW MEXICO No. 1.

Operator.—American Fuel Company, Denver, Colo.

Mine.—Weaver mine, located in the SE. ¼ of sec. 34, T. 16 N., R. 18 W., New Mexico principal base meridian. This mine is 3 miles north of Gallup, McKinley County, N. Mex., on a branch line of the Atchison, Topeka and Santa Fe Railroad.

Sampler.—Marius R. Campbell.

Coal beds.—Two coal beds are worked at the Weaver mine. The upper bed is known as No. 3 and the lower as No. 3½. They are separated by an interval of 5 feet 10 inches of hard sandstone. There are separate openings on the two beds; that on No. 3 is a drift mine going in on the outcrop of the coal; that on No. 3½ is a slope mine. Two sections shown in fig. 7 were measured in this mine. Section A is a measured section of bed No. 3 at a distance of about 2,000 feet in the mine. Section C is a measured section of bed No. 3½ at a distance of about 600 feet in the mine. The sections are as follows:

Sections of coal beds in Weaver mine of the American Fuel Company, near Gallup, N. Mex.

Section A.			Section C.		
	Ft.	*in.*		*Ft.*	*in.*
Sandstone roof.			Sandstone roof.		
Coal	4	1	Draw slate (sandy)	1	6
Fire-clay floor.			Coal	6	3
			Fire-clay floor.		

The beds so far as observed are absolutely free from partings or lenses of shale or sulphur, and the coal is clean so far as visible impurities are concerned.

Samples for chemical analysis.—Two samples were obtained in this mine for chemical analysis. Sample A–B was obtained from coal bed No. 3 at the point where section A was measured. The coal for this sample was obtained by making a cut from roof to floor of the coal bed. The sample was crushed and quartered down according to the usual method. When last divided one quarter was put in a galvanized-iron can and sent to the testing plant, marked sample A. The opposite quarter was sent in the same way and marked sample B. Sample C–D was obtained from coal bed No. 3½ at the point where section C was measured, 600 feet from the mouth of the mine. The sample was obtained by making a cut from roof to floor. About 40 pounds of coal was obtained, which was pulverized and quartered down by throwing out opposite quarters, until the last time the quartering was done two samples of about 1 quart each remained. These were sealed in galvanized-iron tubes and mailed to the chemical laboratory.

Character of car sample.—The coal as it comes from the mine is usually screened over a half-inch screen. That which passes over the screen is sometimes also screened over a 4-inch screen, the coal being thus separated into lump and engine coal. The fine coal passing through the half-inch screen is passed over a rocking screen and a pea coal is saved, which is used almost exclusively by the Santa Fe Railroad for fuel for stationary engines at the various pumping stations. The remainder, which is dust and small fragments of coal less than one-fourth inch in diameter, is lost, being blown out in great heaps of waste.

The mine was visited before the testing plant was in operation, so the collector was unable to load a car for testing purposes. The coal, however, is so uniform in character that this supervision was considered unnecessary, and later a car was loaded by the operator with one-half lump coal screened over a half-inch screen and one-half slack. The coal was shipped in a box car which left Gallup August 17 and was received at the testing plant October 3, 1904.

Equipment and use.—The Weaver mine is well equipped with modern appliances for mining, and has an output of about 1,500 tons daily. The coal is all mined by hand and the cars are gathered into trips by mules. The trips are brought out of both mines by steam power. The roof is good in both mines, being composed of hard sandstone, but in the mine on No. 3½ the draw slate is taken down in the entries to prevent accidents. Little timbering is required, which is an important item in this desert country. The mines are very dry and water has to be pumped in to prevent dust explosions.

Most of the lump coal of this mine goes to the Pacific coast and to intermediate points. The coal which passes over a half-inch screen and through a 4-inch screen is known as engine coal, and practically the entire output of this grade of coal is used on locomotives of the Santa Fe Railroad.

The company is opening a new mine about 1 mile from the old mine. The only other mine on these beds is the Clark mine at Clarksville, 4 miles west of Gallup. Most of the output of this mine goes to Jerome for use in the plant of the United Verde copper mine.

The only outlet to this field for the present is the Santa Fe Railroad, which crosses the southern point of the field at Gallup.

NEW MEXICO NO. 2.

Operator.—Caledonian Coal Company, Gallup, N. Mex.

Mine.—Otero mine, located in the NE. ¼ of the NW. ¼ of sec. 14, T. 15 N., R. 18 W., New Mexico principal base meridian. It is about 3 miles east of Gallup, McKinley County, N. Mex., on the north side of the Atchison, Topeka and Santa Fe Railroad, with which it is connected by a short spur.

Sampler.—Marius R. Campbell.

Coal beds.—Three coal beds are opened in this mine, Otero, Thatcher, and Crown Point, but active mining is carried on only in the first two. The Crown Point bed is opened, but is held in reserve. The thickness of the beds is shown by sections in fig. 7. Section A represents the Crown Point bed, section B the Thatcher bed, and section D the Otero bed. The sections are as follows:

Sections of coal beds in Otero mine of the Caledonian Coal Company, near Gallup, N. Mex.

Section A.			Section B.			Section D.		
	Ft.	*in.*		*Ft.*	*in.*		*Ft.*	*in.*
Coal	3	5	Coal	4	0	Coal	1	2
Shale	0	8				Shale	0	9
Coal	1	5				Coal	3	2
Total	5	6	Total	4	0	Total	5	1

Samples for chemical analysis.—Four samples were taken in this mine for chemical analysis. In all cases the samples were obtained by making cuts from roof to floor, throwing out the shale partings shown in sections A and D. Each sample weighed about 20 pounds. These were crushed and quartered down to about 1 quart each and then mailed in air-tight galvanized-iron cans to the testing plant. Sample A was obtained from the Crown Point bed, but as this is not mined at present this analysis should not be compared with the analysis of the car sample. Samples B and C were obtained from the Thatcher bed and are duplicate samples composed of opposite quarters of the large sample. Sample D is from the Otero coal bed. All samples were obtained at the points where sections were measured.

Character of car sample.—One of the great drawbacks in commercial mining in this field is the great amount of waste or fine coal, which can be seen in large heaps at all of the mines. The principal hope in the district is that some product of briquetting will be produced that will be cheap enough to be used in this field. For experiments in this direction the car was loaded by the operator with slack coal obtained from the Thatcher and Otero seams. The coal was shipped in a box car on August 30 and was received at the testing plant September 26, 1904.

Equipment. The Otero mine is not operated on a large scale and the equipment is of a simple character. The coal beds, however, are easily accessible, and a large output could be maintained were there demand enough to warrant the equipment of the mine.

SPECIAL SAMPLE OF NEW MEXICO COALS.

The Hagen coal field lies east of Algodones, a station on the Santa Fe Railroad about 27 miles north of Albuquerque. A branch line of the Santa Fe Central is building into this field and probably its coal bed will soon be developed on a commercial scale. The Hagen mine is driven in on the Hopewell coal bed at a dip of about 15°. A sample for chemical analysis (No. 1012) was obtained near the end of the main entry about 700 feet from the mouth of the mine, where the bed has a thickness of 4 feet 1 inch, without partings. The sampling was done by Marius R. Campbell on August 17, 1904.

RESULTS OF TESTS.

The results of tests on the New Mexico coals are not very satisfactory. At the time they were received at the testing plant no material which could be used as a binder had been secured for briquetting tests and, although some of this coal was held until a binder was received, the time was too short to make satisfactory tests. The character of the coal from the Weaver and Otero mines is so nearly the same that results obtained on one of these coals are applicable to the others also. As shown on pages 1422, 1446–1448, fairly successful briquettes were made from this coal, but it is probable that the cost of shipping in the necessary binder would be prohibitive.

At the time these samples were received it was not supposed that they could be used to advantage in the manufacture of producer gas, but later in the season the best results were obtained from lignites of even poorer quality than those from New Mexico. The results obtained in the producer would seem to indicate that the New Mexico lignite would make an admirable fuel and that it would probably produce results similar to those obtained from Colorado No. 1 or even Illinois No. 4.

For the production of power this method of utilizing lignites seems much more promising than any scheme of briquetting that has yet been devised.

NORTH DAKOTA.

The coal resources of North Dakota are extensive, both as to area covered by the coal-bearing rocks and in the number and thickness of the coal beds. The coal, however, consists entirely of brown lignite, which carries between 30 and 40 per cent of moisture, and consequently is a low-grade steam fuel. It slacks badly upon exposure to the atmosphere, and this fact, together with the large amount of moisture, makes transportation expensive, and consequently most of the coal is mined for local use. The output of the State in 1904 was 266,128 short tons.

Thin beds of lignite occur in the eastern part of the State, but workable beds are limited largely to the western half, where they seem to occur in considerable number and thickness. Little effort has been made to trace and correlate the various coal beds, and it is generally supposed that the beds are local in their development and that no bed extends to any great distance geographically.

The most important mining centers in the southern part of the State are Sims, New Salem, and Lehigh, on the Northern Pacific Railroad, in Morton and Stark counties; Wilton, on the "Soo Line," in McLean County, and a few places on the same line in Emmons County.

The developments in the northern part of the State are frequently spoken of as in the Mouse River field, but it is probable that this is connected with the other field and is not a separate and distinct basin. The mines in this field are located at Minot, on the Great Northern Railroad, and at Burlington and Kenmare, on the "Soo Line." All of these localities are in Ward County.

Small developments have also been undertaken in the vicinity of Williston, on the Great Northern Railroad, in Williams County.

North Dakota No. 1.

Operator.—Consolidated Coal Company, Lehigh, N. Dak.

Mine.—Lehigh, Stark County, on the Northern Pacific Railroad.

Sampler.—L. S. Storrs and Marius R. Campbell.

Coal bed.—The beds of coal in the North Dakota field are variable in thickness and not continuous over areas of any considerable size. For that reason they have not been correlated and named.

Only one bed of workable proportions is known in the vicinity of Lehigh, and this is reputed to range from 10 to 20 feet in thickness of clean coal, but not all of this is mined. At the points where samples were taken only the lower part of the bed, having a thickness of 6 feet 4 inches, is worked, but frequently an additional layer about 3 feet thick is taken down from the roof.

Samples for chemical analysis.—Two samples were obtained in this mine for chemical analysis. Sample A was taken in the second south entry at a place about 1,900 feet from the mouth of the mine and includes a thickness of 6 feet 4 inches of coal. Sample B was taken in the first north entry at a place about 2,100 feet from the mouth of the mine and represents the same amount of coal as sample A.

The samples were obtained by making perpendicular cuts across clean faces of the coal bed. The material so obtained was collected on an oilcloth blanket spread on the floor and weighed about 30 pounds per sample. These were crushed to about one-half inch in diameter and quartered down until a quart remained of each sample. The samples were then sealed in galvanized-iron cans and mailed to the chemical laboratory of the testing plant.

Character of car sample.—In ordinary work the coal is loaded into mine cars with forks. This permits the fine coal to remain in the mine and also obviates the necessity of screens in the tipple. The car of coal for testing purposes was loaded in the same manner, and hence it consists, in reality, of screened coal. The coal was loaded in a box car which was shipped from the mine September 17 and was received at the testing plant October 17, 1904.

Equipment and use.—The Lehigh mine is driven in on the outcrop of the coal bed where it shows in the low bluffs of Heart River. The equipment of the mine is simple but efficient. The coal bed lies nearly flat and mules can easily haul the coal from all parts of the mine to the tipple. The only other power required is a small electric plant, which is used to operate two mining machines and a fan and to light the main entries.

In summer the demand for lignite is small and little mining is then done, but during the winter fuel is needed in that cold climate and the mine has then an output of about 350 tons a day. The mine has been in operation about twelve years and supplies fuel for steam and domestic purposes to most of the North Dakota towns along the Northern Pacific Railroad.

NORTH DAKOTA NO. 2.

Operator.—Cedar Coulee Coal Company, Williston, N. Dak.

Mine.—This mine is located in Cedar Coulee, 4 miles southeast of Williston, N. Dak., not far from the line of the Great Northern Railroad.

Sampler.—Sent by owner at the request of Mr. Frederick H. Newell, chief of hydrographic branch of the United States Geological Survey, and sampled later by Marius R. Campbell.

Coal beds.—The coal beds of this field are lenticular in shape, and hence can not be traced for any great distance and correlated with coal beds known in other localities. The coal showing in Cedar Coulee is also visible in the bluff on the east side of Missouri River for a distance of 2 or 3 miles, but it is not of workable thickness across the river nor in the vicinity of Williston.

The lignite in Cedar Coulee has a thickness ranging from 9 to 12 feet, but it is difficult to get a measurement of the entire bed, as only the bottom part is mined. Generally a thickness of 6 or 7 feet is removed, the remainder being left to form the roof of the mine. At the place where the sample for chemical analysis was obtained the part mined has a thickness of 6 feet of clear coal.

Sample for chemical analysis.—One sample was obtained in this mine for chemical analysis. The mine was not in operation at the time it was visited, but the coal was fresh and hard, and a sample was taken about 150 feet from the mouth of the mine. This was obtained by making a cut from top to bottom of the face of coal, here 6 feet thick, and collecting the material on an oilcloth blanket spread on the floor. This sample weighed about 30 pounds; it was pulverized and quartered down until about 1 quart remained. This was placed in a galvanized-iron tube and sealed and mailed to the testing plant.

Character of car sample.—The lignite for testing was not loaded in the presence of an agent of the testing plant, but it probably consisted of screened coal. It was loaded in a box car which was received at the testing plant November 2, 1904.

Equipment and use.—At present the property upon which this mine is located is in litigation and consequently it is not being operated. There is little demand in this vicinity for fuel, except for household purposes, and this makes mining profitable only in the winter season.

The mine is located on the face of the bluff overlooking Missouri River at the mouth of Cedar Coulee. It has no railroad connection, but a spur could easily be built from the Great Northern Railroad at a point about 2 miles east of Williston.

The United States Reclamation Service is planning to utilize this great deposit of low-grade fuel in pumping the river water onto the bottom lands in the vicinity of Williston. If this is done it will create a steady demand for this lignite, which in turn will hasten the development of the field.

RESULTS OF TESTS.

How better to utilize the brown-lignite deposits of this country has been a question that has long attracted attention, but very little progress had been made toward its solution. The lignite disintegrates so badly that it can not be stored or shipped for any great distance, and in order to fit it for shipment many have been working along the line of briquetting, and with fair success so far as the manufacture of briquettes are concerned, but in every case the expenses of the operation and the cost of the binder have been prohibitive.

When the first car of brown lignite was received at the testing plant, experiments were made on the briquetting machines, but with little success. A test was attempted under a steam boiler, but the equipment of the testing plant was not designed for this class of fuel and no satisfactory results were obtained. At this time it was not thought possible to use such fuel successfully in the gas producer, but by the time the second carload had been received at the plant the opinion had gained ground that producer gas could be made from this lignite, and so a trial run was made. The expectations were of so doubtful a nature in the mind of the superintendent of the producer plant that the gas engine was run on a two-thirds load, as it was feared the product of gas would not be sufficient to enable the engine to operate at its full capacity. To the surprise of everyone the lignite worked well in the producer and the gas had a higher calorific value than that from any other coal used. Altogether the trial was highly satisfactory; it seemed to solve the question of the production of power in North Dakota and eastern Montana.

The result of the steam test was so unsatisfactory that there is nothing by which a direct comparison can be made of the efficiency of the fuel used in the producer-gas plant as compared with the efficiency developed in the steam plant. Nevertheless a comparison of the results obtained on other coals under the steam boiler is instructive. The table on page 1199 shows that to produce one electrical horsepower hour in the producer-gas plant required 2.29 pounds of dry North Dakota lignite, whereas to produce the same result in the steam plant required 3.39 pounds of the best West Virginia coal. This means that North Dakota lignite, with the moisture eliminated, will do more work when used in a producer-gas plant than the best coal of the country will do in a steam plant.

These results are startling, but they are full of promise to the owners of lignite deposits and to the users of power in North Dakota, Montana, and Wyoming.

PENNSYLVANIA.

Pennsylvania stands easily first among the coal-producing States of the Union, its output in 1904 being 171,108,976 tons of coal, of which 73,156,709 tons is credited to the anthracite field and 97,952,267 tons to the bituminous field.

The bituminous field lies in the western part of the State and it is so well known that it needs no description. The coals are uniformly of high grade, but they vary greatly, including the coking coal of Connellsville, the almost equally famous Youghiogheny gas coals, and numerous grades of steam, domestic, and other coals.

Only a few samples of Pennsylvania coal were received at the testing plant. This was largely due to the fact that the character of these coals is well known and to the greater desire of those interested to have tests made on coals from remote and less known regions of the West.

In order to test the machinery of the plant when it was first erected two cars of Pennsylvania coal were used. These had been sent to St. Louis by the Pennsylvania Railroad Company for conducting locomotive tests in the Transportation Building. The results obtained with this coal were so satisfactory that they have been included in the regular lists.

The other sample tested consisted of a car of anthracite culm from Scranton in the northern anthracite field.

PENNSYLVANIA NOS. 1 AND 2.

Operator.—Berwind-White Coal Mining Company, Philadelphia.

Mine.—Eureka No. 31 mine, located at Windber, Somerset County, Pa., on the Pennsylvania Railroad.

Coal bed.—The coal bed from which this coal was obtained is not positively known, but it is thought to be bed "B" or Lower Kittanning.

Character of car samples.—This coal was shipped by the operator for use in the locomotive tests that the Pennsylvania Railroad Company conducted in the Transportation Building. The cars were loaded with lump coal, but the size of the screen is not known.

PENNSYLVANIA No. 3.

Operator.—Pennsylvania Coal Company, Scranton, Pa.

Character of car sample.—This car was loaded with anthracite culm for use in briquetting experiments. It may be accepted as representing the great culm heaps for which the anthracite region is famous.

SPECIAL SAMPLES OF PENNSYLVANIA AND OHIO COALS.

Special samples of Pennsylvania and Ohio coals were taken for chemical analysis from various beds, as indicated in the subjoined table.

Special samples of Pennsylvania and Ohio coals taken for chemical analysis.

Laboratory number.	Coal bed.	Mine or country bank.	Town.	County.	Owner.
1032	Pittsburg	McLain's	Meadow Lands	Washington	McLain.
1033	do	Blanche	Anderson	do	Pittsburg-Buffalo Co.
1034	Redstone	Russell	Hackett	do	
1035	Pittsburg	Nottingham	do	do	Pittsburg Coal Co.
1047	do	Colliery No. 1	Ellsworth	do	James W. Ellsworth & Co.
1048	do	Country bank	Clinton	Allegheny	Eaton heirs.
1050	do	Colliery No. 2	Ellsworth	Washington	James W. Ellsworth & Co.
1051	do	Country bank	London, S. H	do	Matchett.
1055	do	Manifold	Manifold	do	
1065	Ames[a]	Natural outcrop	Murdocksville	Allegheny	
1067	Pittsburg	Country bank	Frankfort	Beaver	
1069	do	do	Warriors Point	Washington	McCausland.
1070	do	do	Paris	do	Fulton.
1072	do	do	Frankfort[b]	do	Frank Ollum.
1239	Washington	do	Ryerson Station	Greene	
1574	Finley	do	Island Creek	Jefferson, Ohio	
1575	Pittsburg	do	New Alexandria	do	Davis Scott.
1576	do	do	Georges Run	do	Samuel Waugh.
1577	do		Brilliant	do	
1585	Waynesburg	Crabapple	Durbin	do	
1588	do	Country bank	Zollarsville	Washington	Horn.
1589	do	do	do	do	Do.
1590	Pittsburg	Mine No. 3	Midland	do	Pittsburg Coal Co.
1591	do	Country bank	Sodom, S: H	do	Matchett.
1592	Waynesburg	do	Beallsville[c]	do	

[a] On Bigger Creek.

[b] 1 mile southeast of town.

[c] 2 miles south of town.

Special samples of Pennsylvania and Ohio coals taken for chemical analysis—Continued.

Laboratory number.	Coal bed.	Sampler.	Date.	Sample includes—	Thickness.		Total thickness of bed.		Page of analysis.
					Ft.	*in.*	*Ft.*	*in.*	
1032	Pittsburg	F. G. Clapp and F. W. De Wolf	Aug. 27	All worked	5	9	5	9	272
1033	do	do	Aug. 29	Main bench	5	4			272
1034	Redstone	do	do	Full bed	3	2	3	2	272
1035	Pittsburg	do	do	Breast and bottom	5	4			272
1047	do	do	Sept. 26	Main bench					272
1048	do	W. T. Griswold	July 12	Full bed	5	2	5	2	272
1050	do	F. G. Clapp and F. W. De Wolf	Sept. 2	Main bench	5	5½			272
1051	do	W. T. Griswold	July 11	All worked	4	11			273
1055	do	F. G. Clapp and F. W. De Wolf	Sept. 3	Main bench	5	8			273
1065	Ames[a]	W. T. Griswold	Sept. 9	Full bed			[a] 2	0	273
1067	Pittsburg	do	Sept. 10						273
1069	do	do	do	Full bed	4	0	4	0	273
1070	do	do	do	do	4	9	4	9	273
1072	do	do	do						273
1239	Washington	F. G. Clapp and F. W. De Wolf	Oct. 11	Lower bench	1	6	3	2	273
1574	Finley	W. T. Griswold		Full bed	4	2	4	2	272
1575	Pittsburg	do							272
1576	do	do		Full bed	5	0	5	0	272
1577	do	do							272
1585	Waynesburg	do	do	do	3	0	5	9	273
1588	do	do	Oct. 15	Upper bench	1	8	5	0	273
1589	do	do	do	Lower bench	2	10	5	0	273
1590	Pittsburg	W. T. Griswold		Full bed	4	6	4	6	273
1591	do	do		do	4	10	4	10	272
1592	Waynesburg	F. G. Clapp and F. W. De Wolf		Main bench					272

[a] About.

RESULTS OF TESTS.

Steam tests made on Pennsylvania Nos. 1 and 2 were highly satisfactory. It is an excellent fuel for steam raising. It was not tried in the producer-gas plant, but doubtless it would show equally well in this use.

The briquetting tests made with anthracite culm (Pennsylvania No. 3), both when mixed with West Virginia coking coal and when used alone, show that with not more than 7 per cent of hard pitch good briquettes can be made of this material and at a cost so low that the operation must be regarded as commercially possible.

TEXAS.

Texas ranks low as a coal-producing State, the output in 1904 being 1,195,944 short tons. This small production is not due to the size of the fields, for they are very extensive, stretching across the State in an unbroken line of outcrop from its northeast corner to the Mexican border, but rather to the fact that most of the coal is brown lignite, and this has not come into common use.

The coal fields of the State are three in number, consisting of a Carboniferous field in the northern-central part of the State, a Cretaceous field in the vicinity of Eagle Pass on the Mexican border, and the great Tertiary or brown lignite field that crosses the entire State in a northeast-southwest direction.

The coals sent to St. Louis for testing purposes all came from the last-mentioned field, in the northern part of the State. The coal beds in this field are irregular in thickness and occurrence and can not be traced and correlated from district to district. The field contains an immense amount of fuel, and a better method for utilizing it may lead to great development of the field and the establishment of large industries.

The samples came from Houston and Wood counties from mines in good working order and capable of supplying a large amount of fuel.

TEXAS No. 1.

Operator. Houston County Coal and Manufacturing Company, Crockett, Tex.

Mine. Located at Wootter's station, 11 miles south of Crockett, on the International and Great Northern Railroad.

Sampler. Marius R. Campbell.

Coal bed. The coal beds of this field are irregular and have not been specifically named. They occur interbedded with sand and clay and these soft beds weather down to a surface so smooth that coal outcrops are obscured and actual tracing on the surface is impossible.

The thickness of the bed of lignite is shown in fig. 8 by two sections which were carefully measured in this mine. Section A was taken in room 17 off the third north entry 800 feet from the foot of the shaft, and section B was taken in the main entry 600 feet from the foot of the shaft.

Sections of coal bed in mine of the Houston County Coal and Manufacturing Company, Wootter's station, Texas.

Section A.	Ft. in.	Section B.	Ft. in.
Coal and clay roof.		Coal and clay roof.	
Coal	5 0	Coal	5 8

Samples for chemical analysis. Two samples were obtained in this mine for chemical analysis. They are marked sample A and sample B, and they were taken where sections A and B were measured, respectively.

The samples were obtained by making cuts from roof to floor across working faces of coal that previously had been cleaned of weathered coal and impurities, and the coal so procured was pulverized and quartered down until each sample consisted of about 1 quart of fine coal. This was placed in a galvanized-iron can, sealed air-tight, and mailed to the chemical laboratory for analysis.

The sulphur in this coal bed occurs in a peculiar manner. So far as the eye can detect it is present only in the nearly vertical joint planes, which occur at intervals of 4 or 5 feet. This occurrence seems to show that the sulphur was deposited subsequent to the formation of the coal, and was probably carried to its place by circulating water.

The samples for chemical analysis were cut between these joint planes and hence they do not show quite so high a percentage of sulphur as the carload sample.

Character of car sample.—The car sample sent to the testing plant was screened over a one-half inch bar screen. It was loaded in a box car, which was shipped October 8 and received at the testing plant October 26, 1904.

Equipment and use.—The coal is reached in this mine by a shaft 35 feet deep. The ordinary room-and-pillar system of mining is followed, and the coal is delivered to the foot of the shaft by tail rope and mules.

The present daily capacity is about 300 tons. This is largely controlled by the demand for this class of fuel, and doubtless the capacity could be greatly increased if commercial conditions warranted.

The lignite is used in near-by places for domestic purposes and by power plants, but the tendency to disintegrate under the influence of the weather makes long shipments and storage impossible.

TEXAS No. 2.

Operator.—Consumers Lignite Company, Dallas, Tex. This property has changed hands since the sample was shipped.

Mine.—Mines Nos. 1 and 2, located at Hoyt, Wood County, Tex., on the Missouri, Kansas and Texas and Texas Short-Line railroads.

Sampler.—Marius R. Campbell.

Coal bed.—This coal bed has not been identified at any other point, and so has not been named. The coal occurs about 25 feet below the surface, and its thickness is shown in fig. 8 by two sections which were measured in the mine. Section A was measured in the second south entry in mine No. 1, about 500 feet from the mouth of the mine, and section B was taken in the air course, near the foot of the air shaft in mine No. 3. The sections are as follows:

Sections of coal bed in mine of the Consumers Lignite Company, Hoyt, Tex.

Section A.	Ft.	in.	Section B.	Ft.	in.
Carbonaceous shale roof.			Carbonaceous shale roof.		
Lignite	8	3	Lignite	7	10
Clay floor.			Clay floor.		

Samples for chemical analysis.—Two samples were cut in these mines for chemical analysis. Sample A was cut in mine No. 1 at the point where section A was measured. The sample was obtained by making a cut from roof to floor, collecting the fragments on an oilcloth sheet and pulverizing and quartering these down to quart size. The sample was then sealed in a galvanized-iron tube and mailed to the chemical laboratory of the testing plant. Sample B was obtained in a similar way from mine No. 3, at the point where section B was measured. It was sealed in the same manner and mailed at once to the testing plant.

The lignite is free from partings of all kinds, and so the samples represent the entire face of the coal.

Character of car sample.—The coal is loaded into mine cars with forks, and all that which the forks will not lift is regarded as slack and left in the mine. When the mine cars reach the tipple they are dumped directly into railroad cars without further screening.

The lignite was loaded in a box car, which was shipped from the mine on November 16 and reached the testing plant November 25, 1904.

Equipment and use.—The coal in these mines is reached in both cases by slopes. No. 3 is a new mine, but No. 1 has been in operation a number of years. No. 3 is worked by convict labor. The coal in this mine is of about the same character as that previously described from Houston County, and the same difficulty has been experienced in its use.

At one time, a number of years ago, a briquetting plant was established in the Rockdale district, near the central part of the State. Many expected that this would solve the question of the better utilization of these lignites, but the enterprise was not successful, and no further effort has been made to develop this method of utilizing the fuel. Every operator is hoping for something that will improve the quality of the coal or some arrangement for its better utilization.

RESULTS OF TESTS.

Briquetting tests were desired upon these lignites, and these were carried on to some extent at the testing plant, but without success.

The most important tests made, and these seem to solve the question of the method of utilizing lignite for the production of power, were the producer-gas and gas-engine tests. The results are shown on pages 1201–1226. No tests were made of this lignite under the boilers, but it is possible to compare the results obtained with this fuel used in the producer-gas plant and the results obtained by using the best West Virginia coals under the steam boiler. As shown on pages 1211 and 1224, it required 2.22 and 1.71 pounds of dry Texas lignite to produce one electrical horsepower hour and 3.39 pounds of dry West Virginia coal (p. 872) to produce the same result. Thus the tests show that when used in the producer this lignite in a dry state will produce more power than the best West Virginia steam coal under the boiler. This result is surprising, and its effect will surely be the appreciation of value of the lignite deposits and their more extended use in the development of new industries where they are abundant.

WEST VIRGINIA.

West Virginia is one of the great coal-producing States of the Union, being exceeded in point of production only by Pennsylvania and Illinois. In 1904 the output of coal in West Virginia was 32,602,819 short tons.

The coal-producing territory of the State includes a large part of the central Appalachian field. Many well-known workable seams of coal are included in this field, and correlations of the various beds have been fairly well established.

Roughly the State may be divided into two great mining regions, one of which lies in the northern part of the State and the other in the southern part. The principal coal beds worked in the northern field are the Pittsburg and Upper Freeport. In the southern field the coal-bearing measures are thicker and many more beds are present. The five principal groups of coal beds in ascending order are (1) Pocahontas, (2) New River, (3) Lower Kanawha, (4) Upper Kanawha, and (5) Pittsburg.

The samples received at the testing plant represent the Pittsburg and Upper Freeport beds of the northern field, the Pocahontas and two associated beds in the Tug River field, the Quinnimont and Sewell beds of the New River field, and the Ansted and Powellton beds of the Lower Kanawha group. The Upper Kanawha group and Pittsburg coal of the southern field are not represented.

West Virginia No. 1.

Operator.—Virginia and Pittsburg Coal and Coke Company, New York City, N. Y.

Mine.—Kingmont mine, on west bank of Valley River at Kingmont, Marion County, W. Va., on Baltimore and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—This is the well-known Pittsburg coal of the Fairmont district and as such needs little description. The coal shows the same characteristics that are found at almost every point where this famous bed is normally developed. The sections shown in fig. 8 were measured in the Kingmont mine. Section A was measured in room [illegible] in the second right entry and section 3 was measured in room 4 in the [illegible] east entry. The sections are as follows:

Sections of coal bed at [illegible]

Section [illegible]		Section [illegible]	
			[illegible]
Coal	[illegible]	Coal	[illegible]
Shale	[illegible]	Shale	[illegible]
Coal	[illegible]	Coal	[illegible]
Shale	[illegible]	Shale	[illegible]
Coal	[illegible]	Coal	[illegible]
Shale	[illegible]	Shale	[illegible]
Coal	[illegible]	Coal	[illegible]
Total	[illegible]	Total	[illegible]

Samples for chemical analyses.—Two samples for chemical analysis were obtained in this mine. Sample [illegible] was taken from the point where section [illegible] was measured and sample 3 from the point where section 3 was measured. Each sample was obtained by making a cut from roof to floor across a face that had been stripped of the loose and weathered coal. This material amounted to 30 or 40 pounds and was crushed and thoroughly mixed, after which it was carefully quartered down to about 3 pounds, packed in a hermetically sealed galvanized-iron cylinder, and mailed to the chemical laboratory. Both samples were treated in the same way.

Character of car sample.—A box car was loaded for testing purposes with between 30 and 40 tons of run-of-mine coal. There was only a small percentage of slack in this coal, the tipple being well equipped with means for making run-of-mine coal and box cars, and, as a result, the coal was only slightly shattered in loading. The principal impurity in this coal is iron pyrites in the form of knife blades. There is so small a percentage of this, however, that it is of no great importance. The car of coal for testing was shipped from the mine on September 11 and was received at the testing plant [illegible].

Equipment and use.—This is a large and well-planned mine. The drift mouth [illegible] distance below the outcrop, but the coal is reached by a tunnel running up to the bed on a grade averaging [illegible] per cent. The underground workings [illegible] on the double-entry plan and the coal is undercut by hand. A tail-rope haulage system is used from the end of the main haulage way to the tipple, which is located on the opposite side of the river and is connected to the mine [illegible] by a steel bridge. This tipple is equipped with screens for classifying the coal into "lump," "nut," and "slack" size. Any two of these grades can be loaded in a car at the same time without altering the screens. There are 50 beehive ovens near the tipple, in which the slack is used in the production of a good grade of coke. The other uses to which this coal is put are steaming, gas making, household use, and foreign export. The daily capacity of the mine is 1,500 tons. Philadelphia is the principal distributing center for this coal, although a considerable quantity goes to the western cities. The transportation facilities are excellent. The Baltimore and Ohio Railroad runs past the tipple, the new Wabash right of way is near at hand, and Valley River, directly under the bridge, affords slack-water connection with the Monongahela River.

West Virginia No 2.

Operator.—Pitcairn Coal Company, Clarksburg, W. Va.

Mine.—Pitcairn mine, Clarksburg, W. Va., on Baltimore and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The bed of coal worked at this mine is the Pittsburg coal. This well-known bed needs little description. The two sections of the coal bed shown in fig. 8 were measured in the Pitcairn mine. Section A was measured at the face of the third right entry and section B at the face of the fourth left entry. The sections are as follows:

Sections of coal bed in Pitcairn mine of the Pitcairn Coal Company, Clarksburg, W. Va.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	1	1	Coal	2	8¼
Shale	0	¾	Shale	0	¾
Coal	6	0	Coal	6	1
Total	7	1¾	Total	8	10

The parting is extremely variable in its position, and is likely to occur at any point in the upper part of the bed. The coal in this mine has a maximum thickness of 8½ feet and a minimum thickness of 7 feet.

Samples for chemical analysis.—At each point where the above sections were measured a sample was taken for chemical analysis. These samples were obtained by making cuts from roof to floor across faces of the coal that had been previously cleaned of loose coal and powder stains. The samples included all of the bed except the partings which the miner is supposed to throw out on loading the mine cars. The samples were then crushed and quartered down until quart samples were obtained; these were sealed in galvanized-iron cans and mailed to the chemical laboratory.

Character of car sample.—At the time the mine was visited there was a shortage of coal cars, and as this shortage continued for several days the actual loading of the coal was intrusted to Mr. Sydney Britt, the manager of the Pitcairn Coal Company. Mr. Britt reported that run-of-mine coal of the same grade as the commercial product was loaded in a box car for testing purposes. This car was shipped September 21 and received at the testing plant October 2, 1904.

Equipment and use.—The Pitcairn mine lies about one-half mile back from the tipple, and all coal is hauled by steam locomotives from the drift mouth to the tipple. The inside haulage at present is entirely by animals, but the company is contemplating the installation of a continuous haul from inside the mine to the tipple by electric locomotives. The coal is undercut by hand, and the room-and-pillar system of working is followed. This mine produces about 400 tons of coal a day, and the entire output is devoted to the interests of the Pittsburg Plate Glass Company. The coal company expects, in the near future, to place some of its product on the open market. The only railroad at this mine is the Baltimore and Ohio.

WEST VIRGINIA NO. 3.

Operator.—West Virginia Coal Company, Morgantown, W. Va.

Mine.—Richard mine, on Morgantown and Kingwood Railroad, 4 miles southeast of Morgantown.

Sampler.—J. Shober Burrows.

Coal bed.—The coal bed operated at this mine is the Upper Freeport. This bed is broken up into several benches separated from each other by shale and fire clay.

Following is a complete section of this bed, as reported in Vol. II, West Virginia Geological Survey, page 417:

Section of coal bed in Richard mine.

	Ft.	in.
Gray shale.		
Black slate	2	4
Impure cannel coal	0	6
Bony coal	0	8
Coal, "main bench"[a]	2	10
"Little slate," gray	0	2
Coal, "mining ply"[a]	1	2
"Big slate" (fire clay)	4	0
Coal "bottom"	1	4
Total	10	8

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[a] Part worked.

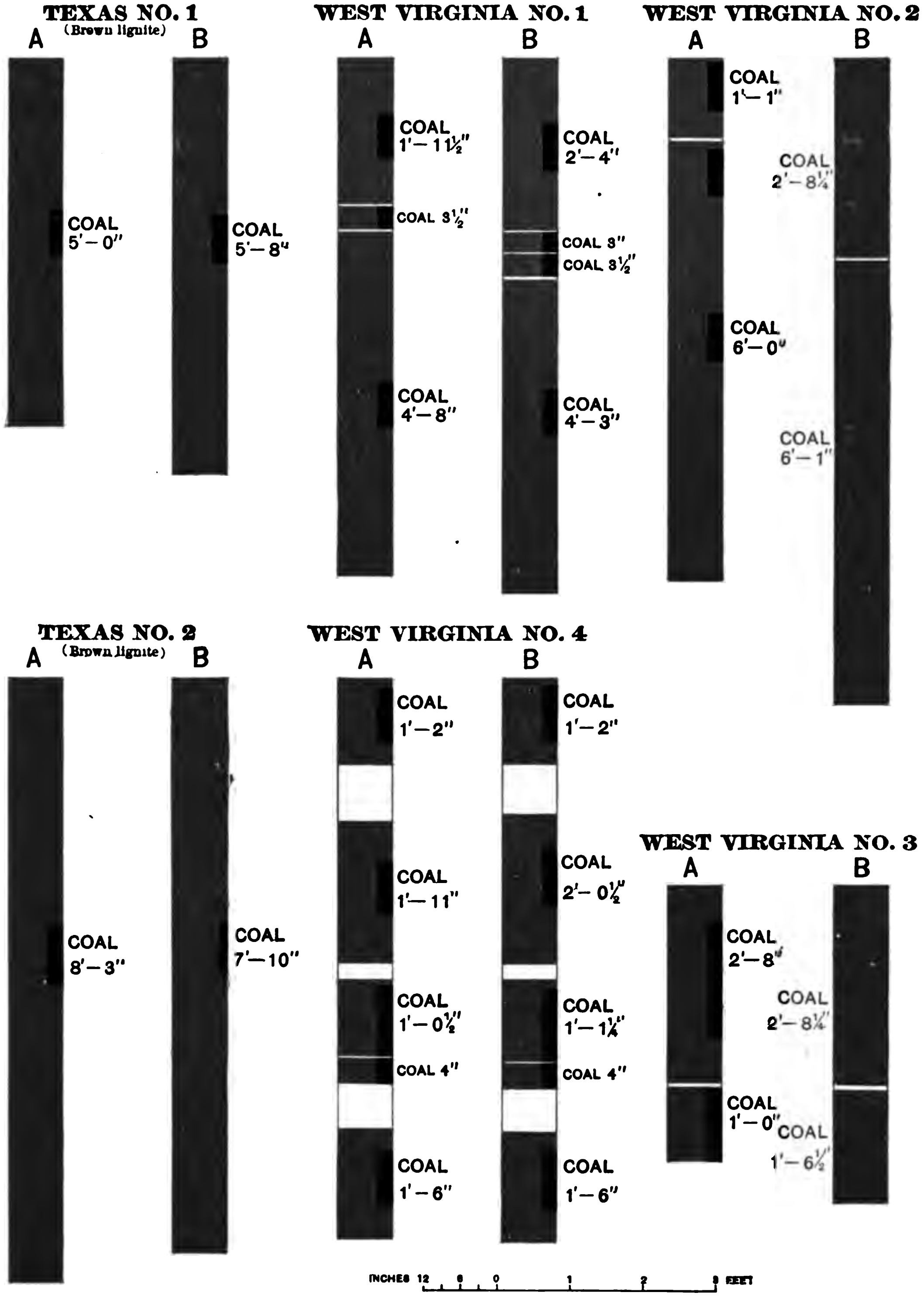

FIG. 8.—Sections of Texas and West Virginia coal beds.

The two sections shown in fig. 8 were measured by the sampler in this mine. Section A was measured in the fourth right entry off the main entry, and section B was measured in the air way near the fourth left entry. These sections are as follows:

Sections of coal bed in Richard mine of the West Virginia Coal Company, near Morgantown, W. Va.

Section A	Ft.	in.	Section B.	Ft.	in.
Bone.			Bone.		
Coal	2	8	Coal	2	8¼
Slate	0	1½	Slate	0	1¼
Coal	1	0	Coal	1	6¾
Total	3	9½	Total	4	4¼

By comparing these sections with the complete section given above it will be seen that the two benches of coal correspond to the "main bench" and "mining ply" of the complete section.

Samples for chemical analysis.—Two samples for chemical analysis were taken from the Richard mine, one from the point where section A was measured, and one from the point where section B was measured. In taking these samples the face of the coal was stripped of loose and weathered coal and a groove was cut about 2 inches broad and an inch deep entirely across the workable portion of the bed, exclusive of the "little slate" shown in the sections. This material was crushed and quartered down until only sufficient remained of each sample to fill a quart can. These cans were hermetically sealed and mailed to the chemical laboratory.

Character of car sample.—A box car was loaded with run-of-mine coal for testing purposes. This coal was soft and bright, but contained pieces of slate from the parting shown in the above sections, and pieces of the bone which is left to help support the roof. Run-of-mine was shipped, as it seemed most desirable to experiment with the product of the mine with a view to finding some way of reducing the impurities associated with the coal, for the purpose of improving the coke made at the mine. This coke is very brittle and needs strengthening. The car was shipped from the mine on September 23 and was received at the testing plant October 5, 1904.

Equipment and use.—The Richard mine has been in operation for about two years. The coal is worked from the outcrop and the double-entry system of mining is followed. Most of the coal is cut by hand. Some air-punching machines are in use, however, and these cut about 7 per cent of the daily output of the mine, which averages about 225 tons. In mining the coal it is undercut just above the shale band, and then shot up from the bottom as well as down from the top. The haulage is by rope and mules.

The West Virginia Coal Company has 150 coke ovens at this mine, and nearly half of the output goes into them for coking. Most of the remainder goes to the large cities of the East, but some is consumed by the locomotives of the Morgantown and Kingwood Railroad. This railroad follows the course of Deckers Creek to Morgantown, where it connects with the Baltimore and Ohio Railroad as well as with slack-water transportation on the Monongahela River.

West Virginia No. 4.

Operator.—West Virginia Coal Company, Morgantown, W. Va.

Mine.—Bretz mine, Bretz, Preston County, W. Va., 7 miles northwest of Kingwood, on Morgantown and Kingwood Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—At Bretz the Upper Freeport coal is being mined by the same company that operates the Richard mine, described under West Virginia No. 3. The coal here is practically of the same structure and the same quality as at the Richard mine, except that it seems to contain less sulphur. The sections shown in fig. 8 were measured in the Bretz mine. Section A was measured at the face of the first right room off the main entry and section B at the face of the first left room off the main entry. The sections are as follows:

Sections of coal bed in mine of the West Virginia Coal Company, Bretz, W. Va.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Sandstone.			Sandstone.		
Draw slate	0	6	Draw slate	0	6
Coal	1	2	Coal	1	2
Bone	0	8	Bone	0	8
Coal [a]	1	11	Coal [b]	2	½
Shale [a]	0	2½	Shale [b]	0	2¼
Coal [a]	1	½	Coal [b]	1	1¼
Shale [a]	0	½	Shale [b]	0	½
Coal	0	4	Coal	0	4
Shale	0	8	Shale	0	8
Coal	1	6	Coal	1	6
Total	8	½	Total	8	2½

[a] Part worked 3 feet 2½ inches.

[b] Part worked 4 feet 1¼ inch.

The benches that are worked carry very bright, clean coal, somewhat soft and friable, but apparently the best part of the bed.

Samples for chemical analysis.—Two samples were obtained in the mine for chemical analysis. Sample A was obtained at the place where section A was measured and sample B at the place where section B was measured. The loose and weathered coal was removed from the face of the coal and a groove was cut from roof to floor directly across the face, exclusive of the shale partings shown in the sections. The samples derived from these cuts weighed about 25 pounds each. Each lot was crushed and quartered down until about one quart remained. This was placed in a galvanized-iron can, sealed air-tight, and mailed to the chemical laboratory.

Character of car sample.—At the Bretz mine a box car of run-of-mine coal was loaded for testing purposes. Owing to the manner of loading, this coal was probably more shattered than the average run-of-mine when loaded into an open car. This car was shipped from the mine September 22 and received at the testing plant October 10, 1904.

Equipment.—The Bretz mine is very similar to the Richard mine in equipment except that the coal is all cut by hand. A compressed-air plant was being installed at the time the visit was made, and the company has planned to cut all the coal with air punching machines. The mine entrance is on the outcrop and the coal is mined by the room-and-pillar system. Hauling is done by mules. As the mine had been in operation but little more than a year and the machinery was not completely installed, it was impossible to form even an approximate estimate of the daily capacity, but it seems probable that when the mine is fully developed it will become a large producer.

WEST VIRGINIA No. 5.

Operator.—Davis Colliery Company, Elkins, W. Va.

Mine.—Coalton mine, Coalton, Randolph County, W. Va., on Coal and Coke Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The most prominent and best-developed coal in Randolph County is the Upper Freeport bed, or, as it is known locally, the Roaring Creek coal. This bed is being mined extensively by the Davis Colliery Company at three mines, Junior, Harding, and Coalton. The Coalton mine is perhaps a fair example of the others. The sections given in fig. 9 were measured in the Coalton mine. Section A was measured at the face of the fifth right heading and section B at the face of the sixth left heading. The sections are as follows:

Sections of coal bed in Coalton mine of the Davis Colliery Company, Coalton, W. Va.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Bone	0	4–6	Bone	0	4–6
Coal	2	0	Coal	1	6½
Shale	0	¼	Shale	0	2¼
Coal	3	4	Coal	3	3½
Shale	0	3½	Shale	0	2¾
Coal	1	5	Coal	1	7
Total	7	5¾	Total	7	3

In these sections all parts are mined except the bone at the top, giving about 7 feet of available coal in section A and about 6 feet 9 inches of available coal in section B. Owing to the position of the partings in this coal, it is rather difficult to mine, but by bearing in just above the lower shale and shooting the bottom coal as well as the top it is possible to obtain the entire face of good coal.

Samples for chemical analysis.—Two samples for analysis were obtained in this mine. Sample A was obtained at the place where section A was measured and sample B from the place where section B was measured. The points at which sections A and B were measured were cleared of all loose and weathered coal and a cut was made from roof to floor, which included all of the bed except the shale partings. The material obtained from these sections weighed about 20 pounds per sample. This was crushed and quartered down to 3 or 4 pounds per sample and packed in air-tight galvanized-iron cylinders, which were immediately mailed to the chemical laboratory.

Character of car sample.—A box car was loaded for testing purposes with coal that had been run over a 1½-inch screen. This grade was accepted, as all coal is screened in this way before going to market. The car was shipped from the mine on September 27 and received at the testing plant October 7, 1904.

Equipment and use.—The Coalton mine is well equipped with modern machinery and appliances. The underground workings are on the room-and-pillar plan. The coal is undercut by hand, just above the lower shale band, and shot down. It is also necessary to shoot the bottom coal. The coal is hauled to the drift mouth by electric motors. In order to get sufficient tipple height above railroad grade, it was found necessary to put the tipple floor some distance above the level of the mine entrance. The drift mouth is connected to the tipple by a short plane up which the loaded cars are drawn separately by an endless chain, which is geared to an electric motor and runs continuously. A Phillips cross-over dump is used in connection with this chain, making the tipple almost automatic. This equipment has a daily capacity of 1,500 tons. The entire output of slack passes through the screens to a conveyor, which delivers it to a large steel bin built over the railroad track. This slack is run through a revolving screen in the top of the bin, and a large percentage of the slate and bone is eliminated. Under the bin are run electric lorries, which distribute the slack to two batteries of a hundred beehive coke ovens each. The coal from the steel bin also can be loaded into railroad cars through chutes arranged over the railroad track. The coal is shipped to the principal cities of the East for steam purposes. Almost all of the slack is converted into coke, which is sold in the open market.

West Virginia No. 6.

Operator.—The New River Smokeless Coal Company, Rush Run, Fayette County, W. Va.

Mine.—Rush Run, Fayette County, W. Wa., on Chesapeake and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The Quinnimont (Fire Creek) coal bed is worked at this mine. The coal is of remarkably fine quality, but it is exceedingly irregular in thickness and many mines along New River have been forced to abandon work on this account. In the Rush Run mine the coal bed varies greatly, ranging from a few inches to 7 or 8 feet in thickness. The thicker part is represented in fig. 9 by two sections, which were measured in this mine. Section A was measured in room 22 off the ninth right entry, and section B was measured in room 10 off the tenth left entry. The sections of the coal bed are as follows:

Sections of coal bed in Rush Run mine of the New River Smokeless Coal Company, Rush Run, W. Va.

Section A.			Section B.		
	Ft.	in.		Ft.	in.
Coal	5	0	Coal	5	6

Samples for chemical analysis.—At the two points where these sections were measured samples were taken for chemical analysis. Sample A was obtained at the place where section A was measured and sample B from the place where section B was measured. A cut was made from roof to floor of the face selected after it had been prepared by stripping off the loose and weathered coal. The material thus obtained was crushed and quartered down to samples about a quart in size and packed separately in air-tight galvanized-iron cylinders for shipment to the chemical laboratory.

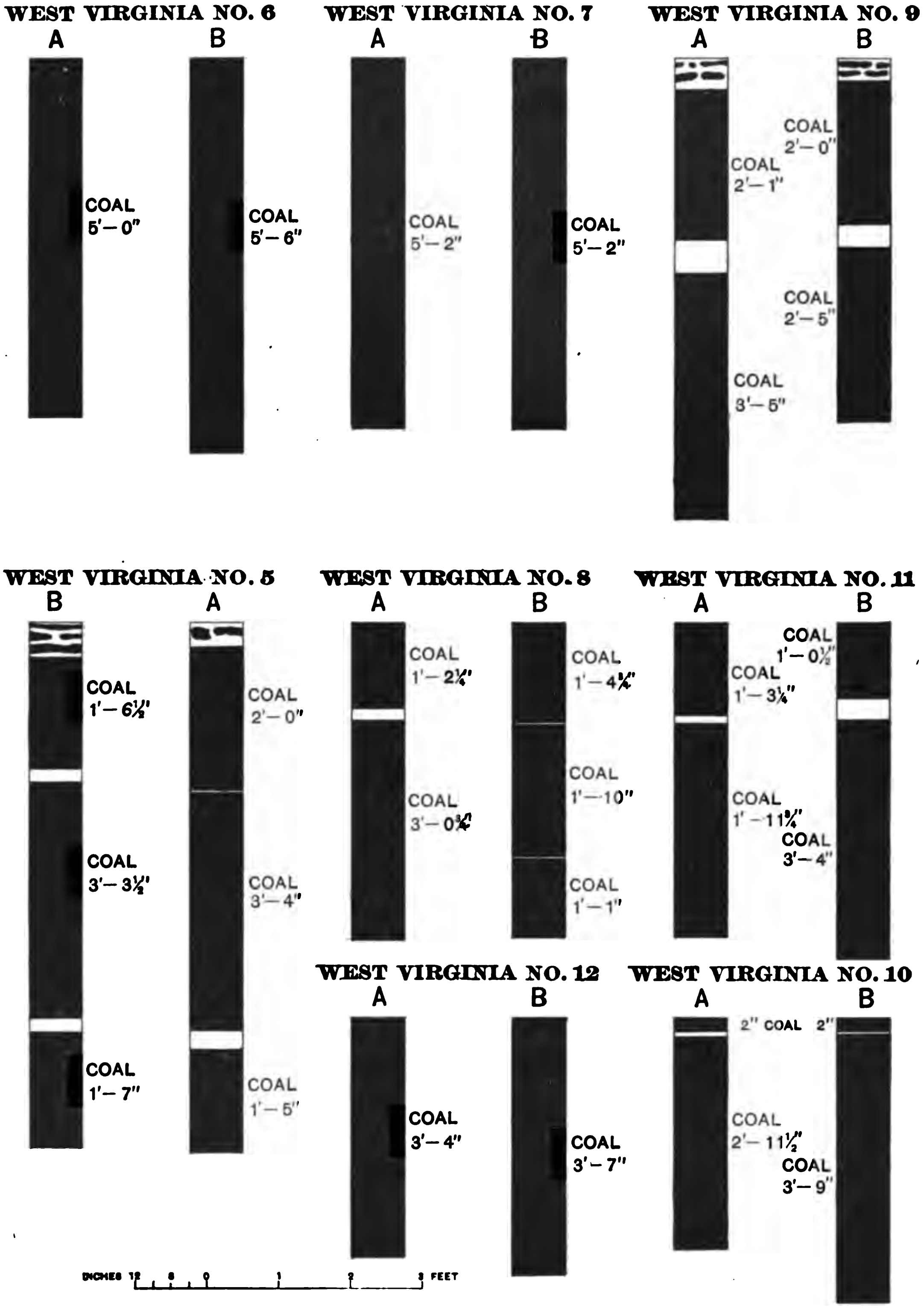

Fig. 9.—Sections of West Virginia coal beds.

Note.—The thickness of the lowest bench in Section A, West Virginia No. 11, should be 2 feet 11¾ inches.

Character of car sample.—Run-of-mine coal was loaded for testing purposes. More than 80 per cent of the coal shipped from this mine is of that grade, although the tipple is equipped with a 3½-inch bar screen and a 1½-inch perforated screen. This coal is classed among the smokeless coals, and is known commercially as the New River coal. The car was shipped from the mine October 3 and was received at the testing plant October 22, 1904.

Equipment and use.—The Rush Run mine is located several hundred feet above railroad grade. From the drift mouth the loaded cars are lowered to the tipple over a steep inclined plane 1,000 feet long. The descent of the loaded cars brings an equal number of empty cars from the tipple to the mine. The inside workings are laid off on the triple-entry system. The inside haulage is by electric motors, and about 75 per cent of the coal is mined by air machines. Some of the slack coal is sold for steam purposes, but most of it is coked at the mine. The lump coal is used largely as a steam coal where smoke ordinances are in effect, as it burns with little smoke. Some of it is exported and a small percentage used for domestic purposes. The daily output of the mine is from 800 to 1,000 tons, most of which finds its way to the large cities in the East and Middle West.

WEST VIRGINIA NO. 7.

Operator.—The New River Smokeless Coal Company, Rush Run, W. Va.

Mine.—Sun No. 1, Sun, Fayette County, W. Va., on the Chesapeake and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal mined at Sun and at other points on Dunloop Creek is the Sewell seam. It occurs from 40 to 70 feet above the Raleigh sandstone and from 320 to 370 feet above the Quinnimont coal. The great regularity in thickness and quality of the Sewell coal and its wide geographic distribution give it a greater value than the Quinnimont bed. The thickness of the bed is shown in fig. 9 by two sections measured in this mine. Section A was measured at the face of the left main heading and section B at the face of the main entry of "the Straight." The sections are as follows:

Sections of coal bed in Sun No. 1 mine of the New River Smokeless Coal Company, Sun, W. Va.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Coal	5	2	Coal	5	2

Samples for chemical analysis.—Two samples were taken in the mine for analysis by making a cut from roof to floor, the face having first been prepared by removing the weathered coal and powder stains. These grooves were cut to such a depth and width that they yielded about 20 pounds of coal per sample. The samples were crushed and quartered down until about one-eighth of the original amount of the material remained, and these final samples were hermetically sealed in galvanized-iron cylinders and mailed to the chemical laboratory.

Character of car sample.—A car was loaded with run-of-mine coal for testing purposes under the same conditions that a car would have been loaded for the market. The tipple is equipped with 3½-inch bar and 1½-inch perforated screens, but run-of-mine coal was decided upon as more truly representing the output of the mine. The coal was loaded in an open coal car, which was shipped from the mine October 4 and was received at the testing plant November 4, 1904.

Equipment and use.—Sun No. 1 mine is one of a number being worked on this creek. The coal is some distance below the surface and is reached by a shaft 160 feet deep. The mine is worked on the triple-entry system and is a large producer. The coal is mined by being undercut by hand and shot off the face. The main haulage is electric, but mules gather the cars from the rooms. The daily capacity of the mine is 1,500 tons, most of which is sold for steam production. Some of the slack is made into coke at the mine, and railroad, steamboat, and household use consume small percentages of the output.

WEST VIRGINIA No. 8.

Operator.—The Gauley Mountain Coal Company, Ansted, Fayette County, W. Va.

Mine.—Gauley Mountain mine, about 1 mile from Ansted, Fayette County, W. Va., on Chesapeake and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The Ansted seam outcrops well up on Gauley Mountain and is slightly more than 4 feet in thickness at various points. There is a parting of shale above the middle of the bed, which varies greatly in thickness, but seldom exceeds 3 inches. This is the only persistent parting in the coal, and is shown in sections given in fig. 9 and below, which were measured in this mine. Section A was measured in room 27, off the ninth entry, and section B was measured in room 15, off the fifteenth entry. The sections are as follows:

Sections of coal bed in Gauley Mountain mine of the Gauley Mountain Coal Company, Ansted, W. Va.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	1	2¼	Coal	1	4¾
Shale	0	2¼	Shale	0	½
Coal	3	¾	Coal	1	10
			Sulphur	Trace.	
			Coal	1	1
Total	4	5¼	Total	4	4¼

Samples for chemical analysis.—At the points where sections were measured samples were cut for analysis. Sample A was obtained from the place where section A was measured and sample B from where section B was measured. In procuring the samples the face of the coal was cleaned of weathered coal and powder smoke. Then a cut was made across the face of the coal, including all of the bed except the shale partings, which are supposed to be thrown out by the miner in regular work. The samples thus obtained were each crushed and quartered down until about a quart remained. This was sealed in a galvanized-iron can and mailed to the chemical laboratory.

Character of car sample.—A car was loaded at this mine with run-of-mine coal coming from widely separated parts of the mine, and as such was representative of the Ansted coal. The coal was loaded in an open coal car, which was shipped from the mine October 5 and received at the testing plant November 4, 1904.

Equipment and use.—This mine is rather unique in its arrangement. The coal being worked at present lies in a long, narrow spur of Gauley Mountain, into which a number of drifts have been driven at right angles to the trend of the spur. These drifts correspond to entries in the usual plan. The main haulway is in daylight and follows the outcrop of the coal.

The coal is mined by hand and at the time of sampling was being hauled to the main road by mules. From the point where the long trips are made up a rope took the cars through a tunnel of considerable length, running under a high ridge. At the farther end of the tunnel steam locomotives took up the trips and hauled them by way of a circuitous tramroad down the mountain to the tipple at Ansted, 2 miles in all from the mine. Electric haulage was being installed at the time of the visit, and it was expected that the new equipment would soon be ready to make one continuous haul from mine to tipple.

At least 20 per cent of the output of the mine is used in the manufacture of coke; the remainder, with slight exception, is used for railway fuel. The daily capacity of the mine is 1,560 tons, and although the property was developed in 1873, the company has scarcely touched its main body of coal, a large acreage of which is still available.

WEST VIRGINIA No. 9.

Operator.—Mount Carbon Coal Company (Limited), Powellton, Fayette County, W. Va.

Mine.—Vulcan, 3 miles south of Powellton, on Powellton and Pocahontas Railroad, a short line connecting with the Chesapeake and Ohio Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—At this mine a coal called the Powellton seam is being mined; it is near the geologic position of the Ansted and the Coal Valley beds, but probably at a slightly different horizon. This is a very regular bed, and has the appearance of being an excellent gas coal. Two sections shown in fig. 9 were measured in the Vulcan mine. Section A was measured in an entry on the extreme north side of the mine and section B was measured on the extreme south side of the mine. The sections are as follows:

Sections of coal bed in the Vulcan mine of the Mount Carbon Coal Company (Limited), Powellton, W. Va.

Section A.			Section B.		
	Ft.	*in.*		*Ft.*	*in.*
Bone	0	5	Bone	0	4
Coal	2	1	Coal	2	0
Shale	0	6	Shale	0	4
Coal	3	5	Coal	2	5
Total	6	5	Total	5	1

Samples for chemical analysis.—Two samples were taken in this mine for chemical analysis, sample A at the point where section A was measured and sample B at the point where section B was measured. These samples were obtained in the customary manner by making a cut from roof to floor after the face had been cleared of the loose and weathered coal. The material thus obtained was crushed and quartered down to one-eighth in quantity for each sample, and these were packed in air-tight galvanized-iron cylinders and mailed to the chemical laboratory at St. Louis.

Character of car sample.—The car loaded for testing purposes at the Vulcan mine contained run-of-mine coal, clean and bright, containing the average amount of slack usually loaded at this mine with this grade of coal. Some of the small pieces were highly colored and iridescent, or what is commonly called peacock coal. The coal was loaded in a gondola car which was shipped from the mine October 6 and received at the testing plant November 18, 1904.

Equipment and use.—The Mount Carbon Coal Company (Limited), operates two mines near Powellton. In the Vulcan mine, from which the sample was obtained, the coal is undercut both by hand and air-punching machines, and hauled to the tipple by compressed-air locomotives. This method is soon to be abandoned, however, and electric haulage installed throughout the mine. This coal is used principally for making coke, about 200 ovens of the ordinary beehive type being kept almost continuously in blast. The coal is crushed very fine before coking and a high grade of coke is produced. The coal is also used for gas making and for steam purposes. The mine is about fifteen years old, and the daily production of coal ranges from 400 to 900 tons.

WEST VIRGINIA NO. 10.

Operator.—Stuart M. Buck, Bramwell, W. Va.

Mine.—Experimental drift, Mora, Mercer County, W. Va., on the Norfolk and Western Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The bed of coal from which this sample was taken is designated by Mr. Buck the No. 6 coal bed. It is not being worked commercially at present in this region, but as its appearance indicates a good grade of coal it was thought desirable to test it for coking and steaming purposes. Accordingly a drift was driven from the outcrop to solid coal and several coking tests were made by the operator before a sample was shipped to the testing plant. The Sagamore Colliery Company has a number of coke ovens and a complete mining equipment on the property. It has for some time been mining the Pocahontas coal, immediately below the bed from which the sample was taken, but operations were recently discontinued at this point. It is probable, however, that the company will open mines on the upper bed if the quality of the coal warrants it, although the coal is somewhat thinner than the Pocahontas bed. Two sections of coal shown in fig. 9 were measured in this experimental mine. Section A was measured at a point midway between the entrance and the face of the drift, and section B at the face of the drift. The sections are as follows:

Sections of coal bed in the experimental mine of Stuart M. Buck, Mora, W. Va.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	0	2	Coal	0	2
Bone and sulphur	0	2	Bone and sulphur	0	2
Coal	2	11¼	Coal	3	9
Total	3	3¼	Total	4	1

Samples for chemical analysis.—Two samples were obtained from this mine for chemical analysis. Sample A was taken from the point where section A was measured, and sample B from the point where section B was measured. They were procured in the usual manner, by making a cut directly across the face of the coal from roof to floor and throwing out the parting of bone and sulphur. About 20 pounds of material was obtained for each sample, and this was quartered down to about 4 pounds. These ultimate samples were packed in air-tight galvanized-iron cylinders and mailed to the laboratory at the testing plant.

Character of car sample.—The coal to be tested was not loaded in the presence of the sampler, as, owing to the temporary character of the mine, adequate facilities for loading a car in a reasonable time were not at hand. From the drift mouth the coal was dumped into a steep chute about 300 feet long, constructed of rough boards and provided with three gates distributed at different distances along the length of the chute. By falling down this chute and striking the gates the coal was greatly shattered, and the great quantity of slack which was thus produced was increased by dropping the coal from the end of the chute into a mine car. It was then hauled to a tipple, where it was again dropped onto a five-eighths-inch screen, which removed some of the slack. The coal was loaded in an open coal car, which was shipped from the mine on October 10 and received at the testing plant November 8, 1904.

West Virginia No. 11.

Operator.—W. H. Coffman, Bluefield, W. Va.

Mines.—Zenith Nos. 1 and 2, Zenith, McDowell County, W. Va., on the Norfolk and Western Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal mined at this point is the No. 3 or Pocahontas bed. This is the most important coal of the Pottsville series, and it is second in importance in the Appalachian field to the great Pittsburg seam. The extent of this deposit is not comparable to the area of the Pittsburg coal, but its excellent steaming qualities and low sulphur content have earned for it a place preeminent among the steam coals of the world. The Zenith mines are not located in the heart of the Pocahontas field, but the coal seems to be normally developed, although it is not so thick here as in the older parts of the field. Fig. 9 gives two sections from the Zenith mines. Section A is from mine No. 1 and section B is from mine No. 2. The sections are as follows:

Sections of coal in Zenith mines Nos. 1 and 2, of W. H. Coffman, Zenith, W. Va.

Section A.	Ft.	in.	Section B.	Ft.	in.
Coal	1	3¼	Clay "muck" (4¼ inches).		
Bone	0	1¾	Coal	1	½
Coal	2	11¾	Bone	0	3¼
			Coal	3	4
Total	4	4¾	Total	4	7¾

Samples for chemical analysis.—At the points where the above sections were measured samples were taken for analysis, sample A from the point where section A was measured and sample B from the point where section B was measured. The loose and powder-burned coal was removed, and a trench about 2 inches wide and 1 inch deep was cut across the face from roof to floor, including everything except the partings thrown out by the miner in loading his coal. About 20 pounds of material for each sample having been secured in this way, the samples were thoroughly mixed and quartered down to about 4 pounds. These ultimate samples were packed in air-tight galvanized-iron cans and mailed to the chemical laboratory at the testing plant.

Character of car sample.—The car shipped to the testing plant was loaded with run-of-mine coal. This coal was carefully cleaned by three pickers, who worked under the direction of a competent inspector employed by the sales agents for the district. All coal mined in the Pocahontas field is subjected to this same rigid inspection, and the excellent quality of the coal is due in a large measure to the care with which the coal is picked. The car of coal was shipped from the mine on October 11 and received at the testing plant November 10, 1904.

Equipment and use.—The capacity of these mines is about 300 tons a day. This is for both mines, which are on the outcrop and have tramroads to the same tipple. Electric haulage has been installed, and the coal is cut by air machines just below the bone. The coal is then shot from the roof. These mines are new and rather small, but the company has a large acreage of coal and proposes to extend its operations.

West Virginia No. 12.

Operator.—Big Sandy Coal and Coke Company, Marytown, W. Va.

Mine.—Big Sandy mine, Big Sandy, McDowell County, W. Va., on the Norfolk and Western Railroad.

Sampler.—J. Shober Burrows.

Coal bed.—The coal mined at this point is known to the trade as Tug River coal and is called by the operator the No. 8 seam. It is a bright, clean bed of coal, without partings and with few sulphur bands. The bed has been worked in this immediate region for about five years, but little is known of its position with relation to the other well-known beds of West Virginia. Fig. 9 shows two sections of this coal measured in the Big Sandy mine. Section A was measured at the face of the third right entry, and section B was measured at the face of the fifth right entry. The sections are as follows:

Sections of coal bed in mine of the Big Sandy Coal and Coke Company, Big Sandy, W. Va.

Section A.	Ft. in.	Section B.	Ft. in.
Coal	3 4	Coal	3 7

Samples for chemical analysis.—At the same points where the above measurements were made, samples for chemical analysis were taken. Sample A was taken where section A was measured and sample B from the point where section B was measured. A cut was made across the face of the coal from roof to floor and the coal so obtained was crushed and quartered down until a quart sample of each was obtained. These samples were sealed in galvanized-iron cans and mailed to the chemical laboratory at the testing plant.

Character of car sample.—As the sampler arrived at the mine too late in the day to load a car for testing purposes, he accepted a car from among a number standing loaded on the track. This car contained run-of-mine coal of about the quality ordinarily shipped from the mine. It is interesting to note that when this coal is exposed to the weather for a short time it turns a dull olive-green. This does not seem to affect the composition of the coal, nor does it seem to be an indication of a high sulphur content, as the analysis given on page 260 of this report shows the sulphur to be less than 1 per cent. The coal was loaded on an open coal car, which was shipped from the mine on October 12 and received at the testing plant November 1, 1904.

Equipment and use.—The Big Sandy Coal and Coke Company operates only one mine at this point, but it maintains a daily output of 500 tons and has a modern equipment. The underground workings are operated by the room-and-pillar system with two entrances on the outcrop, one for the return of the empty cars and one out of which the loads are hauled. The method of mining the coal is rather unusual in this district, the coal being mined out by hand below the roof and shot up from the bottom, instead of the undercutting method ordinarily employed. The mine is about 300 feet vertically above the tipple, and for many years the coal was lowered over an inclined plane. Recently there has been installed a Jeffery conveyor 400 feet long, which moves at the rate of 170 feet per minute. This conveyor carries the coal from under the weigh-house just outside of the mine to the cars standing under the tipple, and its capacity is far in excess of any demand that is likely to be made upon it. Electric haulage is employed in the mine.

Most of the coal mined here is sold for steam purposes, but some is used in the production of by-product coke and for railroad fuel. Nearly the entire output goes to tide water and the Middle West.

SPECIAL SAMPLES OF WEST VIRGINIA COAL.

Data concerning the special samples of West Virginia coals taken for chemical analyses are given in the subjoined table:

Special samples of West Virginia coal taken for chemical analysis.

Laboratory number.	Coal bed.	Mine or country bank.	Town.	County.	Owner.
1233	Wattsville	Country bank [a]		Nicholas	Packer, Harrison & O'Conner.
1236	do	do.[a]		do	Do.
1237		do.[b]		Webster	Hans Hoover.
1362	Wattsville	do.[c]		Nicholas	Hutchinson.
1363	do	do.[d]		do	
1572	Rogers	do	Zalia	Hancock	
1578		do.[e]	Summersville	Nicholas	Backus farm.
1579	Summersville	do.[f]	do	do	J. E. Sims farm.
1581	Summersville (?)	do		do	John McRader farm.
1582	do	do.[g]		do	C. H. Dunbar farm.
1583	Summersville	Stripping[h]	Summersville	do	Neff farm.
1584	Pittsburg	Country bank [i]	Colliers	Brooke	R. P. Pool.
1586	do	do.[i]	do	do	Mary Patterson.
1594	Finley	do	Zalia	Hancock	

Laboratory number.	Coal bed.	Sampler.	Date.	Sample includes—	Thickness.	Total thickness of bed.	Page of analysis.
					Ft. in.	*Ft. in.*	
1233	Wattsville	George H. Ashley	Oct. 4	Middle and bottom benches.	5 0	12 0	274
1236	do	do	do	Upper bench	6 8	12 0	274
1237		do	Oct. 7	Coal from dump		2 8	274
1362	Wattsville	W. C. Phalen	Oct. 19	Entire bed		7 8½	274
1363	do	do	Oct. 24	Lower bench	3 11	4 9¾	274
1572	Rogers	W. T. Griswold		Full bed	3 0	3 0	274
1578		George H. Ashley	Oct. 30	Coal from dump		4 3½	274
1579	Summersville	W. C. Phalen	Nov. 8	Lower bench	2 11½	4 2	274
1581	Summersville (?)	do	Nov. 2	do	1 11	2 11	274
1582	do	do	Nov. 1	do	2 2	3 6¾	274
1583	Summersville	George H. Ashley	Nov. 4	Entire bed		5 ½	274
1584	Pittsburg	W. T. Griswold		Full bed	4 7	4 7	275
1586	do	do					275
1594	Finley	do		Full bed	3 7	3 7	275

[a] Near head of right fork of Muddlety Creek. Sample not quartered.
[b] Two miles northwest of Cowan. Coal taken from various parts of dump.
[c] Near Wood's field, east of Hookersville. Sample not quartered down.
[d] Head of Rader Fork of Twentymile Creek. Sample not quartered down.
[e] One mile south of Summersville. One bushel of coal from dump.
[f] Three-fourths mile from Summersville. Cut across face of lower bench.
[g] On Fitzwater branch of Peters Creek, west of Summersville.
[h] Head of McKee Creek, 1 mile west of Summersville. Excludes 2½-inch bone.
[i] One mile south of station.

RESULTS OF TESTS.

The steam tests made at St. Louis show that all of the West Virginia coals are high-grade steam coals—in fact they are decidedly in the lead in this respect of all coals tested. West Virginia No. 6, or coal from the Quinnimont bed on New River, made the best showing of the coals tested.

All of the coals from this State are coking coals, but notwithstanding this fact coking tests were made at St. Louis. In several cases these tests were made in connection with washing tests to see if the quality of coke could not be improved. The results are shown in the chapters headed "Coking tests" and "Washing tests."

In briquetting, the tests which have the most direct bearing on the fuel question of this State are those which produced briquettes from coke breeze with or without the addition of a small amount of raw coal. The briquettes made by both methods were hard and burned well, and doubtless would make a good substitute for anthracite coal. The results obtained with New River coal and coke could without question be duplicated with any other coking coal of the State, and it seems that this might open up an important industry which would utilize a waste product and produce a valuable fuel.

Probably the most important tests were those made in the producer-gas plant, because these tests point to an entirely new method of utilizing fuels for the production of power. Such tests were made of Pittsburg and Upper Freeport coals from the northern part of the State, of Sewell coal from Dunloop Creek, of Ansted and Powellton coals from the Kanawha district, and of Pocahontas coal from Elkhorn Creek.

The results given on pages 1236, 1246, 1256, 1267, 1289, 1302 show that for the production of one electrical horsepower hour in the producer-gas plant there were required 1.57, 1.29, 1.46, 1.78, 1.40, and 1.50 pounds of dry coal, respectively, while to produce the same result in the steam plant (pp. 824, 848, 880, 888, 896, 920) it took 3.90, 3.62, 3.55, 3.63, 3.46, and 3.53 pounds of dry coal, respectively. These tests show gains in efficiency over the fuel used in the steam plant of 148, 181, 143, 104, 147, and 135 per cent, respectively.

Such results indicate a revolution in the production of power, and as soon as the apparatus is perfected, gas producers and gas engines are certainly destined to replace to a large extent the ordinary steam engine.

WYOMING.

Wyoming is one of the important Rocky Mountain coal-producing States, ranking second to Colorado in this respect. In 1904 it stood eleventh in coal production, with an output of 5,178,556 short tons.

Wyoming contains a number of coal fields that appear at present to be separate and independent. The coal beds occur in rocks of Cretaceous age, and there are two widely separated horizons from which the coal is obtained. Most of the beds occur in the Laramie formation, the uppermost member of the Cretaceous system, but in the eastern part of the State coal beds occur near the base of the system in the Lakota sandstone.

Samples were sent to the testing plant from the Newcastle field, in the northeastern part of the State, and from the Powder River field, in the northern central part of the State. The sample from the Newcastle field was obtained from a bed in the Lakota sandstone and the sample from the Powder River field from a bed in the Laramie formation.

WYOMING No. 1.

Operator.—Wyoming Coal Mining Company, Monarch, Wyo.

Mine.—Monarch mine, 9 miles northwest of Sheridan, Sheridan County, Wyo., on Burlington and Missouri River Railroad.

Sampler.—Frank W. De Wolf.

Coal bed.—The coal mined at Monarch lies in a field which is said to extend 5 miles to the north and west, over 40 miles eastward, and to the southeast beyond Gillette a distance exceeding 80 miles.

Geologically the coal occurs in the Laramie formation, about 500 feet above the Fox Hill sandstone. It is thought to be the fourth in a series of 25 beds. At Dietz, 4 miles southeast of Monarch, beds Nos. 9 and 10 are mined. The twenty-fifth coal bed outcrops at Gillette. The beds between Nos. 4 and 9 are said to exceed 14 feet in thickness, while those lying between Nos. 10 and 25 are more than 12 feet thick.

The coal is a shiny black lignite, free from partings, ranging from 28 to 32 feet in thickness. Usually the upper 6 feet of coal are interbedded with shale, leaving a workable thickness of from 22 to 26 feet.

Samples for chemical analysis.—Two samples for chemical analysis were obtained in this mine. These were cut from working faces, at points about 1,600 feet from the shaft. They were cut from the full height of the faces, furnishing coal from every part of the bed. These samples were crushed to a uniform size, quartered down to about 1 quart in size, and mailed in air-tight galvanized-iron cylinders to the chemical laboratory.

Character of car sample.—A box car was loaded with lump that had passed over a 5-inch screen. This coal disintegrates very rapidly, and on this account, in view of the long haul, it was thought best to load the largest size coal. The car was shipped from the mine on November 1 and was received at the testing plant November 19, 1904.

Equipment and use.—The Monarch mine is on the outcrop, entrance being by a drift with a main haulage way extending more than 1,600 feet in a southwesterly direction. The coal is hauled out of the rooms by mules, and delivered to the rope in the main haulage way, which carries it to the tipple. The coal is cut by compressed-air pick machines and shot down. About 1,000 tons of coal are mined here daily. Approximately one-third of this is used by locomotives, the remainder being divided equally between manufacturing industries and household use.

WYOMING NO. 2.

Operator.—Cambria Fuel Company, Cambria, Wyo.

Mine.—Antelope Nos. 1, 2, and 3, and Jumbo mines, all delivering coal to one tipple. These mines are located in sec. 29, T. 46 N., R. 61 W., on a branch line of the Burlington and Missouri River Railroad.

Sampler.—Frank W. De Wolf.

Coal bed.—The coal bed worked in these mines occurs in the Lakota sandstone near the base of the Cretaceous system. It is probably a local bed, limited to this general locality.

The thickness and character of the coal bed are illustrated in fig. 10 by sections measured in different parts of the mines. Section A was measured in room 6 off the third northwest entry in Antelope No. 3 mine; section B, in room 9 off the eighth northwest entry in Jumbo mine; section C, in room 7 northwest in Antelope No. 1 mine; and section D, in room 14 in Antelope No. 1 mine. The sections are as follows:

Sections of coal bed in Cambria mines of the Cambria Fuel Company, Cambria, Wyo.

Section A.			Section B.			Section C.			Section D.		
	Ft.	*in.*		*Ft.*	*in.*		*Ft.*	*in.*		*Ft.*	*in.*
Sandstone			Shale, black.			Sandstone.			Sandstone.		
Coal	2	0	Coal (cannel?)	0	2	Shale, black	0	4	Shale	0	3
Coal, splint	0	7	Coal	0	2	Clay	1	5	Bone	1	7
Coal	0	6	Coal, splint	0	7	Bone	0	3	Coal, splint	0	2¾
Coal, splint	0	2	Coal	0	10	Clay	1	0	Clay	0	1
Coal	1	10	Clay	0	1½	Coal	1	5	Coal	2	9
Coal, splint	0	10	Coal	0	3	Sulphur	0	0½	Fire clay.		
Coal	0	6	Coal, splint	0	5	Coal	1	2¼			
Coal, splint	0	3	Coal	1	2½	Clay	0	3			
			Coal, splint	0	3	Coal	1	8½			
			Coal	0	4	Fire clay.					
			Clay	0	2						
			Coal	1	0						
Total	6	8	Total	5	6	Total coal seam	4	7¼	Total coal seam	3	¾

Samples for chemical analysis.—Two samples were taken in these mines for chemical analysis. The samples were obtained by making cuts from roof to floor, exclusive of such partings and binders as are commonly removed in mining. Sample A was made up from a sample cut at the point where section A was measured and one from the point where section C was measured. In making the cut at section C the sulphur and the clay partings were excluded from the sample. The sulphur band is very troublesome in mining. Generally it appears as shown in the section, but locally it increases in thickness to 1 and 2 inches, and carries large balls of sulphur. The sulphur was excluded from the sample for the reason that an effort is made to pick out the sulphur as the coal is loaded. The coal from the two cuts was crushed, carefully mixed, and quartered down to 1 quart. This was sealed air-tight in a galvanized-iron can and mailed to the testing plant. Sample B was obtained by making a similar cut in the Jumbo mine at the point where section B was measured. It included everything from roof to floor except the two clay partings. This sample was crushed, quartered down, and mailed to the testing plant in the same manner that sample A was treated.

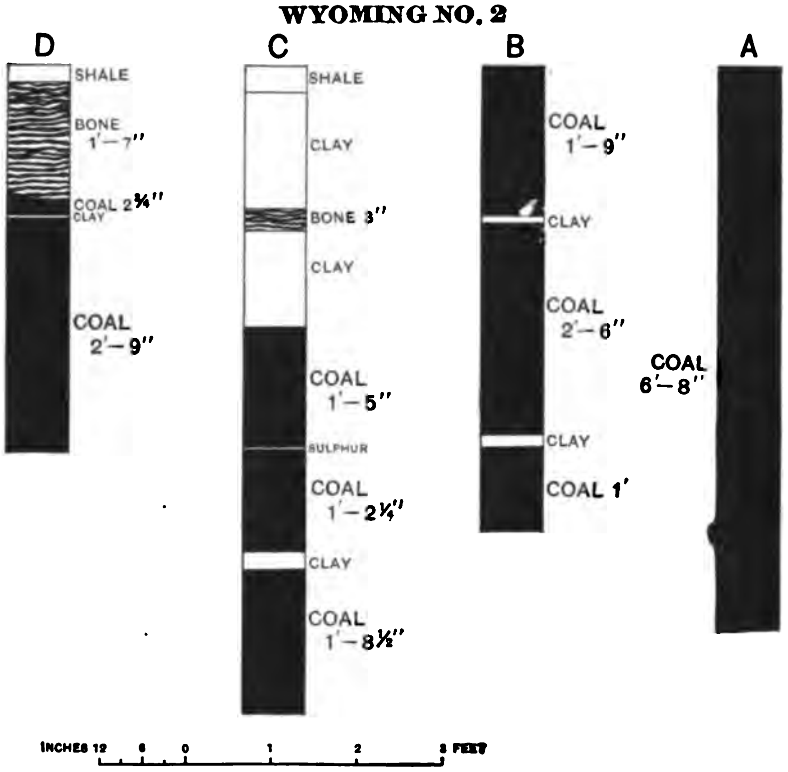

FIG. 10.—Sections of Wyoming coal beds.

Character of car sample.—This coal is used largely as engine coal by the Burlington and Missouri River Railroad. For this purpose it is crushed and screened over a ¼-inch screen. The coal comes from the mine in large lumps and also as fine coal. It is crushed to make it of uniform size, and screened to remove the fine coal. About 30 per cent of the crushed coal passes through the ¼-inch screen.

In order to have the commercial grade of coal for testing purposes, the car was loaded with engine coal; that is, run-of-mine crushed and screened over a ¼-inch screen. This was loaded in an open coal car. It was shipped from the mine on November 3 and received at the testing plant November 14, 1904.

Equipment and use.—The coal bed outcrops at the surface and the mines are drift mines driven in on the outcrop. All of the mines are connected by tramroads with one tipple, and the coal is brought to this place for crushing and screening.

The mines are well equipped with air mining machines, and the main hauling is done by air motors and by cable. The mine has three openings west of the tipple and two to the east, the entire length of workings being over 2 miles.

The slack coal is generally coked at the mine, but the coke is so high in ash that it is difficult to market the product. The great problem in this field is the better utilization of the slack coal and the elimination of ash.

RESULTS OF TESTS.

Steam tests on the samples of Wyoming coal show that it is a low-grade fuel, at least for this purpose. The results obtained on the coal from Cambria are lower than those from the Sheridan lignite, but this is due in large measure to the heavy percentage of ash that is carried by the Cambria coal. The recalculated analysis, in which the ash is thrown out, shows that the Cambria coal is superior to the other.

Some briquetting tests were made on these samples, but they gave no promise of success in a commercial way.

The best results were obtained by using this coal in the producer-gas plant. The results given on page 1313 show that with Wyoming No. 2 it required 2.07 pounds of dry coal to produce one electrical horsepower hour, whereas when used in the steam plant (p. 944) it required 5.9 pounds of dry coal to produce the same result. It is probable that equally good or better results could have been obtained with Wyoming No. 1, since in general the quality of the gas improves as one descends in the scale of quality of coal, the best results being obtained from brown lignite.

The results obtained by the use of lignite in the producer-gas plant are full of promise for this region, for they show that by this method of utilization these low-grade fuels may become as valuable as the best grades of West Virginia coal used in a steam plant.

COMMERCIAL VALUE OF COAL-MINE SAMPLING.

INTRODUCTION.

Does mine sampling show the commercial value of a coal; and if so, how should it be done? This question is often asked, but seldom answered. During the past summer, while engaged in securing coal for the Government coal-testing plant at St. Louis, the writer had a good opportunity to obtain information on this subject, and the results seem to furnish an answer to the questions propounded above.

SAMPLING FOR GEOLOGICAL SURVEY COAL-TESTING PLANT.

In organizing the work of the testing plant, it was decided that coal in carload lots only would be accepted for testing, and it was further decided that this coal should be loaded under the immediate supervision of a representative of the plant, so as to be certain that the carload sample would be representative coal. As an additional check on the work, two mine samples were to be collected from each mine visited, and these samples, as well as the sample from the car when it was received at the testing plant, were to be carefully analyzed at the chemical laboratory, which was established in connection with the plant and operated under the direction of Prof. N. W. Lord, of the Ohio State University, Columbus, Ohio.

MINE SAMPLING.

Mine samples were collected with great care by the writer and his assistants, Mr. J. Shober Burrows, Mr. John W. Groves, and Mr. Frank W. De Wolf.

The dominant idea in the regulations which were adopted for mine sampling was that it should be done in such a manner that the sample would have the same composition as the commercial output of the mine.

When samples were to be procured from a certain place the mine was examined to see the coal before it was mined—its benches, partings, roof, and floor, and any peculiarity that might be present. The methods of mining were observed, and also the efforts that were made in the mine and at the tipple to free the coal from its accompanying impurities.

Two points were then selected for sampling in widely separated localities in the mine. The floor was carefully cleaned and an oilcloth blanket spread to catch the coal and to prevent it from becoming mixed with fragments of shale or other dirt and to keep the sample from collecting an undue amount of moisture in places where the floor was wet.

A cut was made about 3 inches wide and 1 inch deep across the face of the coal from roof to floor, including thin and irregular shale, clay, or sulphur partings such as the miners fail to separate from the coal, and excluding thick partings or dirty coal that usually are thrown out by the miners. The object was to get as near a good grade of merchantable coal as possible with the methods of mining and handling in vogue at the mine.

The sample so obtained consisted of 25 or 30 pounds of coal, which was usually placed in a bag and taken to the surface, where it was crushed and quartered down. Sometimes it was reduced at once to the desired degree of fineness (about one-half inch), but more frequently it was pulverized to three-fourths inch and divided into quarters. Then opposite quarters were taken and crushed again until it was reduced to about one-half inch. It was then quartered again until the resulting sample contained about one quart of fine coal. This was placed in a galvanized-iron can provided with a screw top, which was screwed down tightly and the joint bound with tire tape, making the can air-tight. These sample cans were then mailed directly to the chemical laboratory, where the coal was immediately transferred to glass jars, in which it was hermetically sealed.

After the inspector procured the mine samples, he went to the surface and observed the loading of a car of coal for testing purposes. He permitted only such hand picking as was commonly done on coal that was to be shipped for the market, and in every way possible provided for representative coal. The grade of coal selected usually depended upon local conditions, but the aim was to take only such coal as was regarded as typical and merchantable.

In the case of a soft coal or lignite, liable to disintegrate under the influence of the weather, box cars were used wherever practicable, but the great bulk of the bituminous coal was shipped in ordinary open coal cars.

Most of the coal was shipped during the months of August, September, October, and November, and during these months the weather was unusually dry in the vicinity of St. Louis. For this reason it seems probable that the coal in transit was but little affected by rain or snow, and that any change in the amount of moisture in the coal was due to ordinary atmospheric conditions that probably had a similar effect on the coal shipped in both open and box cars.

CAR SAMPLING.

When the carload of coal arrived at the testing plant and was unloaded, the coal was passed through rolls having an aperture of 1½ inches, reducing it to a uniform size. As the coal was being elevated by bucket conveyors, a man with a small shovel took samples from the conveyor at regular intervals. By this method a sample of 200 or 300 pounds was obtained from each car, which was then taken to the chemical laboratory for analysis.

The original intention was to unload the car at once into a storage bin, but owing to a scarcity of bins this was not always practicable, and in a majority of cases the coal was unloaded a few tons at a time, only sufficient for some particular test. A sample was taken, however, of the coal used for each test, and the moisture, sulphur, and ash reported in the tables are the results of the analyses of the various samples so taken.

At the laboratory both the mine and car samples were pulverized and quartered down by machinery until a convenient sample was obtained. Part of this was taken for analysis and the remainder was sealed in a glass jar for future reference.

The sample to be analyzed was first air dried until it reached an almost constant weight, and the loss of moisture by this process was determined. The sample was then analyzed and its composition was recalculated on the basis of the coal as received.

ANALYTICAL RESULTS.

During the season 50 separate mines in 14 different States were visited and mine and car samples obtained. The table shows the analyses of these samples so far as moisture, sulphur, and ash are concerned. The analyses of the two mine samples have been averaged, and the per cent of moisture, sulphur, and ash thus obtained is regarded as representing the impurities obtained in mine sampling. The analyses of the various car samples have been averaged, and the result is taken as the amount of moisture, sulphur, and ash in the commercial product of the mine.

Classification of impurities in mine and car samples.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(1) Alabama No. 1:													
Mine sample A	1.35	0.71	13.63	1.28	0.71	13.22	.....	.....	.....	.....	.....	.....	
Mine sample B	1.22	.71	12.81										
Car sample	2.34	.72	12.54	2.52	.75	13.44	1.24	0.04	0.22	.....	.....	.....	Over 1-inch screen.
Steam sample	2.56	.78	13.92										
Coke sample	2.65	.76	13.88										
(2) Alabama No. 2:													
Mine sample A	2.25	1.09	9.04	2.33	1.09	10.08	.....	.....	.....	.....	.....	.....	
Mine sample B	2.42	1.10	11.13										
Car sample	3.36	1.01	12.43	3.93	1.12	12.13	1.60	.03	2.05	.....	.....	.....	Through 8-inch and over ¾-inch screen. Also washed slack.
Steam sample	4.83	1.17	13.54										
Gas sample	3.76	.86	9.50										
Coke sample	3.77	1.43	13.04										
(3) Arkansas No. 1:													
Mine sample A	.75	1.15	6.98	.88	1.12	7.23	.....	.....	.....	.....	.....	.....	
Mine sample B	1.02	1.10	7.49										
Car sample	3.24	1.24	12.61	2.51	1.19	12.89	1.63	.07	5.66	.....	.....	.....	Over 1¼ inch screen.
Steam sample	1.99	1.21	13.04										
Coke sample	2.31	1.13	13.01										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(4) Arkansas No. 2:													
Mine sample A...	.78	2.50	9.09	0.86	2.31	8.03	......	......	......	......	......	.....	Over 1¼-inch screen.
Mine sample B...	.95	2.12	6.97										
Car sample.......	2.23	1.87	9.20	1.87	1.80	9.39	1.01	......	1.36	......	0.51	.....	Do.
Steam sample....	1.07	1.95	8.42										
Coke sample......	2.31	1.58	10.55										
(5) Arkansas No. 3:													
Mine sample A...	1.60	1.42	7.91	1.61	1.44	10.28	......	......	......	......	......	.....	
Mine sample B...	1.63	1.46	12.66										
Car sample.......	2.19	1.28	11.63	2.08	1.28	10.44	.47	......	.16	......	.16	.....	Do.
Steam sample....	1.97	1.29	9.25										
(6) Arkansas No. 5:													
Mine sample A...	1.38	1.52	6.95	1.59	1.73	7.20	......	......	......	......	......	.....	
Mine sample B...	1.80	1.94	7.26										
Car sample.......	2.36	1.99	12.08	2.29	2.19	11.82	.70	0.46	4.62	......	......	.....	Half lump coal, half slack coal.
Steam sample....	2.22	2.39	11.50										
(7) Colorado No. 1:													
Mine sample A...	21.84	.46	3.48	20.93	.49	3.54	......	......	......	......	......	.....	
Mine sample B...	20.02	.52	3.61										
Car sample.......	18.68	.55	5.99	19.57	.52	5.74	......	.03	2.20	1.36	......	.....	Run-of-mine.
Steam sample....	19.78	.42	5.37										
Gas sample.......	20.24	.60	5.85										
(8) Illinois No. 1:													
Mine sample A...	11.17	4.22	10.32	10.61	4.13	10.19	......	......	......	......	......	.....	
Mine sample B...	10.06	4.04	10.07										
Car sample.......	9.75	4.10	13.20	9.97	4.21	14.78	......	.08	4.59	.64	......	.....	Over 1-inch screen.
Steam sample....	9.69	4.40	15.19										
Coke sample......	10.46	4.14	15.95										
(9) Illinois No. 3:													
Mine sample A...	7.50	.99	7.15	7.42	1.51	7.34	......	......	......	......	......	.....	
Mine sample B...	7.34	2.04	7.53										
Car sample.......	8.50	1.72	11.28	8.22	1.59	10.79	.80	.08	3.45	......	......	.....	Run-of-mine.
Steam sample....	8.51	1.50	11.55										
Coke sample......	8.25	1.45	10.59										
Gas sample.......	7.62	1.69	9.73										
(10) Illinois No. 4:													
Mine sample A...	15.09	.83	7.42	14.75	1.17	8.11	......	......	......	......	......	.....	
Mine sample B...	14.42	1.52	8.81										
Car sample.......	12.91	1.32	11.64	12.94	1.34	10.77	......	.17	2.66	1.81	......	.....	Over 2-inch screen.
Steam sample....	13.47	1.28	11.46										
Gas sample.......	12.43	1.41	9.22										
(11) Illinois No. 6:													
Mine sample A...	14.89	3.61	7.87	14.41	3.70	9.39	......	......	......	......	......	.....	
Mine sample B...	13.94	3.79	10.91										
Car sample.......	14.43	4.01	13.28	13.81	3.74	14.08	......	.04	4.69	.60	......	.....	Run-of-mine.
Steam sample....	13.19	3.48	14.88										
(12) Indiana No. 1:													
Mine sample A...	11.50	.96	9.62	12.37	1.41	9.39	......	......	......	......	......	.....	
Mine sample B...	13.25	1.87	9.16										
Car sample.......	11.40	2.50	13.40	11.45	2.55	11.74	......	1.14	2.35	.92	......	.....	Do.
Gas sample.......	11.51	2.61	10.08										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(13) Indiana No. 2:													
Mine sample A	10.32	3.51	8.55	9.80	3.97	8.94	......	......	......	......	......	......	Run-of-mine
Mine sample B	9.28	4.44	9.34										
Car sample	9.62	4.43	13.02	9.15	4.29	11.73	......	0.32	2.79	0.65	......	......	Do.
Steam sample	9.11	4.12	12.45										
Gas sample	8.72	4.23	9.73										
(14) Indian Ter. No. 1:													
Mine sample A	6.77	1.86	5.68	7.82	1.49	7.15	......	......	......	......	......	......	
Mine sample B	8.87	1.62	8.63										
Car sample	7.04	1.92	10.01	7.49	1.62	11.12		.13	3.97	.33	......	......	Over 1¼-inch screen.
Steam sample	7.65	1.80	12.09										
Gas sample	5.00	1.43	8.51										
Coke sample	10.29	1.34	13.86										
(15) Indian Ter. No. 2:													
Mine sample A	1.30	1.58	7.65	1.38	1.48	7.02	......	......	......	......	......	......	
Mine sample B	1.46	1.38	6.40										
Car sample	4.45	1.52	11.00	3.99	1.46	10.25	2.61	......	3.23	......	0.02	......	Run-of-mine.
Steam sample	3.71	1.39	9.77										
Coke sample	3.82	1.47	9.99										
(16) Indian Ter. No. 3:													
Mine sample A	2.93	3.73	10.30	2.95	3.39	9.34	......	......	......	......	......	......	
Mine sample B	2.97	3.05	8.38										
Car sample	4.61	3.68	11.14	4.52	3.57	10.41	1.57	.18	1.07	......	......	......	Do.
Steam sample	4.79	3.93	10.33										
Coke sample	4.16	3.16	9.75										
(17) Indian Ter. No. 4:													
Mine sample A	5.29	3.77	12.13	5.89	3.72	10.72	......	......	......	......	......	......	
Mine sample B	6.50	3.67	9.31										
Car sample	6.24	3.96	13.21	6.24	3.91	13.10	.35	.19	2.38	......	......	......	Over 1-inch screen.
Steam sample	6.24	3.86	12.99										
(18) Iowa No. 1:													
Mine sample A	12.07	4.99	12.33	11.71	4.85	11.42	......	......	......	......	......	......	
Mine sample B	11.35	4.72	10.51										
Car sample	8.24	5.03	16.00	8.46	5.71	17.17	......	.86	5.75	3.25	......	......	Over 1¼-inch screen.
Steam sample	8.69	6.39	18.34										
(19) Iowa No. 2:													
Mine sample A	15.50	5.19	9.19	15.57	5.14	10.41	......	......	......	......	......	......	
Mine sample B	15.65	5.10	11.64										
Car sample	14.21	4.66	15.22	14.54	4.69	15.63	......	......	5.22	1.03	.45	......	Run-of-mine.
Steam sample	14.88	4.73	16.04										
(20) Iowa No. 3:													
Mine sample A	15.90	6.76	12.37	15.16	6.32	11.68	......	......	......	......	......	......	
Mine sample B	14.42	5.89	10.99										
Car sample	13.88	6.15	14.01	13.16	6.11	14.83	......	......	3.15	2.00	.21	......	Over 1¼-inch screen.
Steam sample	12.44	6.07	15.65										
(21) Iowa No. 4:													
Mine sample A	16.14	4.76	11.08	16.63	4.38	9.07	......	......	......	......	......	......	
Mine sample B	17.13	4.00	7.07										
Car sample	14.08	4.26	10.96	13.76	4.65	13.05	......	.27	3.98	2.87	......	......	Do.
Steam sample	13.48	5.04	15.15										
(22) Iowa No. 5:													
Mine sample A	18.59	3.10	7.15	18.64	2.74	7.44	......	......	......	......	......	......	
Mine sample B	18.69	2.39	7.73										
Car sample	15.39	3.19	12.63	15.70	3.14	13.01	......	.40	5.57	2.94	......	......	Run-of-mine.
Steam sample	16.01	3.09	13.40										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(23) Kansas No. 1:													
Mine sample A	2.91	3.79	9.55	3.20	3.53	8.73	......	......	......	......	......	......	
Mine sample B	3.50	3.28	7.92										
Car sample	4.99	4.28	12.97	5.95	4.38	13.15	2.75	0.85	4.42	......	......	......	Run-of-mine.
Steam sample (1)	5.90	3.82	10.86										
Steam sample (2)	4.80	4.94	13.95										
Coke sample	8.10	4.48	14.84										
(24) Kansas No. 2:													
Mine sample A	2.44	5.63	10.60	2.40	5.75	11.19	......	......	......	......	......	......	
Mine sample B	2.36	5.88	11.79										
Car sample	4.18	6.27	17.91	4.07	5.93	18.97	1.67	.18	7.78	......	......	......	Lump and nut.
Coke sample	3.96	5.59	20.04										
(25) Kansas No. 3:													
Mine sample A	2.54	4.47	9.87	2.27	4.87	12.51	......	......	......	......	......	......	
Mine sample B	2.01	5.27	15.15										
Car sample	2.50	5.68	12.45	2.13	5.37	13.80	......	.50	1.29	0.14	......	......	Run-of-mine.
Steam sample (1)	2.03	5.39	13.46										
Steam sample (2)	2.25	4.80	12.40										
Coke sample	1.75	5.60	16.91										
(26) Kansas No. 5:													
Mine sample A	5.11	4.34	8.90	5.45	4.09	10.72	......	......	......	......	......	......	
Mine sample B	5.79	3.84	12.55										
Car sample	4.10	3.77	10.54	4.20	4.08	11.22	......	......	.50	1.25	0.01	......	Over ¾-inch screen.
Steam sample	4.31	4.40	11.91										
(27) Kentucky No. 1:													
Mine sample A	2.91	.89	3.53	2.86	.86	3.16	......	......	......	......	......	......	
Mine sample B	2.81	.84	2.80										
Car sample	3.10	1.22	4.39	2.90	1.21	4.73	.04	.35	1.57	......	......	......	Run-of-mine.
Steam sample	2.89	1.19	5.91										
Coke sample	2.71	1.23	3.90										
(28) Kentucky No. 2:													
Mine sample A	8.49	3.53	7.10	8.14	3.86	8.66	......	......	......	......	......	......	
Mine sample B	7.80	4.20	10.22										
Car sample	7.91	3.62	9.13	7.83	3.49	8.85	......	......	.19	.31	.37	......	Over ¼-inch screen.
Steam sample	7.76	3.37	8.58										
(29) Kentucky No. 3:													
Mine sample A	9.10	2.97	8.05	8.54	3.50	8.67	......	......	......	......	......	......	
Mine sample B	7.98	4.03	9.30										
Car sample	7.92	3.52	10.06	7.71	3.76	9.66	......	.26	.99	.83	......	......	Run-of-mine and over ¼-inch screen.
Steam sample	7.92	3.91	9.92										
Gas sample	7.28	3.86	8.99										
(30) Kentucky No. 4:													
Mine sample A	4.76	3.21	7.01	4.68	3.27	7.20	......	......	......	......	......	......	
Mine sample B	4.61	3.33	7.40										
Car sample	5.27	4.54	14.18	5.58	4.13	13.45	.90	.86	6.25	......	......	......	Run-of-mine.
Steam sample	5.89	3.72	12.72										
(31) Missouri No. 1:													
Mine sample A	4.80	5.35	14.17	4.86	5.34	14.84	......	......	......	......	......	......	
Mine sample B	4.92	5.34	14.52										
Car sample	8.33	5.25	19.86	7.80	4.81	18.28	2.94	......	3.94	......	.53	......	Do.
Steam sample	7.28	4.37	17.20										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(32) Missouri No. 2:													
Mine sample A...	14.74	3.79	7.78	13.82	3.81	9.22	......	......	......	......	......	......	
Mine sample B...	12.90	3.83	10.66										
Car sample.......	11.50	5.16	16.86	11.94	4.81	16.32	......	1.00	7.10	1.88	......	......	Run-of-mine.
Steam sample (1).	13.09	4.92	16.70										
Steam sample (2).	11.57	4.60	16.90										
Gas sample.......	11.60	4.56	14.84										
(33) Missouri No. 4:													
Mine sample A...	13.34	5.06	6.91	11.95	5.03	6.53	......	......	......	......	......	......	
Mine sample B...	10.57	5.00	6.15										
Car sample.......	12.67	5.12	4.83	12.32	5.08	5.22	0.37	.05	......	......	......	1.31	Do.
Steam sample....	12.24	4.98	5.55										
Coke sample......	12.04	5.14	5.27										
(34) New Mexico No. 1:													
Mine sample A...	11.77	.54	3.26	11.36	.53	3.63	......	......	......	......	......	......	
Mine sample B...	10.96	.52	4.01										
Car sample.......	12.29	.63	6.99	12.09	.59	7.83	.73	.06	4.20	......	......	......	Lump and nut.
Steam sample....	11.90	.56	8.68										
(35) Texas No. 1:													
Mine sample A...	33.50	.56	10.75	33.04	.56	10.79	......	......	......	......	......	......	
Mine sample B...	32.58	.56	10.84										
Car sample.......	34.70	.79	11.20	34.10	.71	10.78	1.06	.15	......	......	......	.01	Run-of-mine.
Gas sample.......	33.50	.63	10.36										
(36) Texas No. 2:													
Mine sample A...	28.86	.50	7.92	30.10	.53	8.21	......	......	......	......	......	......	
Mine sample B...	31.34	.57	8.50										
Car sample.......	33.71	.53	7.28	33.71	.53	7.28	3.61	......	......	......	......	93	Do.
(37) West Virginia No. 1:													
Mine sample A...	1.35	1.31	6.42	1.87	1.45	6.54	......	......	......	......	......	......	
Mine sample B...	1.40	1.59	6.67										
Car sample.......	1.75	.90	6.34	1.80	.91	6.57	.43	......	.03	......	0.54	......	Do.
Steam sample....	1.90	.98	7.21										
Gas sample.......	1.61	.87	6.14										
Coke sample......	1.93	.88	6.60										
(38) West Virginia No. 2:													
Mine sample A...	1.87	3.75	8.10	1.92	3.97	8.59	......	......	......	......	......	......	
Mine sample B...	1.98	4.20	9.08										
Car sample.......	1.95	3.48	7.86	1.90	3.19	8.68	......	......	.09	.02	.78	......	Do.
Steam sample....	2.01	2.71	9.96										
Coke sample......	1.73	3.38	8.22										
(39) West Virginia No. 3:													
Mine sample A...	2.21	.80	8.82	2.55	.77	8.25	......	......	......	......	......	......	
Mine sample B...	2.90	.75	8.19										
Car sample.......	2.29	1.06	10.23	2.36	1.14	10.34	......	.37	2.09	.19	......	......	Do.
Steam sample....	2.54	1.38	11.04										
Coke sample......	2.25	.99	9.75										
(40) West Virginia No. 4:													
Mine sample A...	2.26	1.26	8.58	2.26	1.05	8.16	......	......	......	......	......	......	
Mine sample B...	2.26	.85	7.74										
Car sample.......	1.48	.90	8.39	2.18	.88	9.42	......	......	1.26	.08	.17	......	Do.
Steam sample....	2.53	.96	9.99										
Gas sample.......	1.99	.79	8.82										
Coke sample......	2.72	.86	10.50										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(41) West Virginia No. 5:													
Mine sample A...	2.82	1.00	10.45	2.95	1.06	10.36	......	......	......	......	......	.....	
Mine sample B...	3.08	1.13	10.27										
Car sample.......	1.45	.98	10.10	2.00	.96	10.37	......	......	0.01	0.95	0.10	.....	Over 1¼-inch screen.
Steam sample....	2.11	1.01	10.28										
Coke sample......	2.43	.90	10.73										
(42) West Virginia No. 6:													
Mine sample A...	2.10	.75	3.55	2.19	.74	4.71	......	......	......	......	......	.....	
Mine sample B...	2.29	.73	5.88										
Car sample.......	1.53	.65	5.05	1.92	.68	5.22	......	......	.51	.27	.06	.....	Run-of-mine.
Steam sample (1).	2.14	.70	5.45										
Steam sample (2).	2.11	.64	5.03										
Coke sample (1)..	1.76	.55	4.84										
Coke sample (2)..	2.27	.88	5.40										
Coke sample (3)..	1.73	.64	5.58										
(43) West Virginia No. 7:													
Mine sample A...	2.12	.90	3.55	2.30	.99	3.85	......	......	......	......	......	.....	
Mine sample B...	2.48	1.08	4.15										
Car sample.......	3.94	1.16	4.93	3.49	1.35	6.26	1.19	0.36	2.41	......	......	.....	Do.
Steam sample....	2.68	1.52	8.82										
Coke sample......	3.85	1.36	5.02										
(44) West Virginia No. 8:													
Mine sample A...	1.90	.64	4.87	1.87	.76	5.81	......	......	......	......	......	.....	
Mine sample B...	1.84	.89	6.76										
Car sample.......	4.16	.90	7.17	4.41	.84	7.08	2.54	.08	1.27	......	......	.....	Do.
Steam sample....	5.26	.74	6.87										
Coke sample......	3.82	.89	7.20										
(45) West Virginia No. 9:													
Mine sample A...	1.77	.74	2.94	1.87	.79	3.35	......	......	......	......	......	.....	
Mine sample B...	1.98	.85	3.76										
Car sample.......	4.08	.77	6.58	3.49	.85	6.59	1.62	.06	3.24	......	......	.....	Do.
Steam sample....	3.42	.82	6.00										
Gas sample.......	2.66	1.00	5.73										
Coke sample......	3.81	.83	8.07										
(46) West Virginia No. 10:													
Mine sample A...	2.63	.57	3.13	2.78	.52	3.37	......	......	......	......	......	.....	
Mine sample B...	2.93	.48	3.62										
Car sample.......	1.75	.56	4.58	1.70	.59	5.38	......	.07	2.01	1.08	......	.....	Over ¾-inch screen.
Steam sample....	1.74	.59	6.19										
Coke sample......	1.61	.61	5.37										
(47) West Virginia No. 11:													
Mine sample A...	2.21	.44	5.25	2.63	.47	4.91	......	......	......	......	......	.....	
Mine sample B...	3.05	.50	4.57										
Car sample.......	4.07	.51	11.12	4.09	.48	10.52	1.46	.01	5.61	......	......	.....	Run-of-mine.
Steam sample....	4.85	.47	10.48										
Coke sample......	3.35	.47	9.95										
(48) West Virginia No. 12:													
Mine sample A...	1.92	.52	4.39	2.70	.62	4.14	......	......	......	......	......	.....	
Mine sample B...	3.48	.73	3.90										
Car sample.......	1.72	.68	6.87	1.56	.80	6.08	......	.18	1.94	1.14	......	.....	Do.
Steam sample....	1.58	.59	4.83										
Gas sample.......	1.43	.95	6.45										
Coke sample......	1.53	.97	6.16										

Classification of impurities in mine and car samples—Continued.

	Percentages of impurities.			Averages.			Excess in car samples.			Excess in mine samples.			Remarks.
	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	Moisture.	Sulphur.	Ash.	
(49) Wyoming No. 1:													
Mine sample A	21.44	0.53	4.91	21.72	0.56	4.14							
Mine sample B	22.00	.60	3.37										
Car sample	22.63	.59	4.50	22.22	.61	5.26	0.50	0.05	1.12				Over 5-inch screen.
Steam sample	21.81	.63	6.02										
(50) Wyoming No. 2:													
Mine sample A	9.23	4.33	20.97	8.91	4.63	21.43							
Mine sample B	8.60	4.94	21.90										
Car sample	9.44	3.91	20.72	10.27	3.89	19.74	1.36				0.74	1.69	Run-of-mine.
Steam sample	11.10	3.87	18.77										
Total							35.15	9.93	130.94	26.54	4.65	3.94	
Number							26	35	46	24	14	4	
Averages							1.35	.28	2.85	1.11	.33	.98	

Total ash in mine samples	418.36
Total ash in car samples	545.73

CONCLUSIONS.

MOISTURE.

In the table given above the gains and losses in the amount of moisture in the coal are about equally balanced. In the entire lot of 50 samples 26 show a gain of moisture in the average of the car analyses, and the average amount of gain expressed in per cent is 1.39. In 24 cases there is an excess of moisture in the mine sample over the car sample, and the average per cent of excess is 1.11. These figures are so nearly the same that, considered as a whole, there was no perceptible gain or loss of moisture in transit or in the car samples over the mine samples.

In analyzing these figures more closely, however, it is seen that four of the lignites show a gain in moisture and one shows a loss. The lignites showing gain are New Mexico No. 1, Texas No. 1, Texas No. 2, and Wyoming No. 1. These were shipped in box cars, but despite this fact they show a perceptible gain in moisture, while Colorado No. 1, shipped in an open car, shows a loss of moisture. The average of moisture gain in the lignites, taken as a whole, is 0.91 per cent.

The greatest loss of moisture seemed to have occurred in the bituminous coals having an originally high moisture content. As shown in the following table, 19 samples of this kind of coal have a moisture content in the mine samples of 5 per cent or over. These are as follows:

List of coals containing more than 5 per cent of moisture in the average mine sample, exclusive of lignites.

Name of sample.	Average per cent of moisture in—		Excess in—	
	Mine samples.	Car samples.	Mine samples.	Car samples.
Illinois No. 1	10.61	9.97	0.64	....
Illinois No. 3	7.42	8.22	....	0.80
Illinois No. 4	14.75	12.94	1.81	....
Illinois No. 6	14.41	13.81	.60	....
Indiana No. 1	12.37	11.45	.92	....
Indiana No. 2	9.80	9.15	.65	....
Indian Territory No. 1	7.82	7.49	.33	....
Indian Territory No. 4	5.89	6.24	....	.35
Iowa No. 1	11.71	8.46	3.25	....
Iowa No. 2	15.57	14.54	1.03	....
Iowa No. 3	15.16	13.16	2.00	....
Iowa No. 4	16.63	13.76	2.87	....
Iowa No. 5	18.64	15.70	2.94	....
Kansas No. 5	5.45	4.20	1.25	....
Kentucky No. 2	8.14	7.83	.31	....
Kentucky No. 3	8.54	7.71	.83	....
Missouri No. 2	13.82	11.94	1.88	....
Missouri No. 4	11.95	12.32	....	.37
Wyoming No. 2	8.91	10.27	....	1.36
Total	217.59	199.16	21.31	2.88

Average excess of moisture in mine samples, 21.31 ÷ 15 = 1.42 per cent.

Average excess of moisture in car samples, 2.88 ÷ 4 = 0.72 per cent.

Coefficient of decrease from mine sample, 199.16 ÷ 217.59 = 0.915. Therefore, in sampling coals which run 5 per cent or over in the mine sample, the probable amount of moisture in the commercial sample can be obtained by multiplying by the coefficient 0.915.

Twenty-six samples of bituminous coal contain less than 5 per cent of moisture in the mine samples, as follows:

List of coals containing less than 5 per cent of moisture in the average mine sample.

Name of sample.	Average per cent of moisture in—		Excess in—	
	Mine samples.	Car samples.	Mine samples.	Car samples.
Alabama No. 1	1.28	2.52	....	1.24
Alabama No. 2	2.33	3.93	....	1.60
Arkansas No. 1	.88	2.51	....	1.63
Arkansas No. 2	.86	1.87	....	1.01
Arkansas No. 3	1.61	2.08	....	.47
Arkansas No. 5	1.59	2.29	....	.70
Indian Territory No. 2	1.38	3.99	....	2.61
Indian Territory No. 3	2.95	4.52	....	1.57
Kansas No. 1	3.20	5.95	....	2.75
Kansas No. 2	2.40	4.07	....	1.67
Kansas No. 3	2.27	2.13	0.14	....
Kentucky No. 1	2.86	2.90	....	.04
Kentucky No. 4	4.68	5.58	....	.90
Missouri No. 1	4.86	7.80	....	2.94
West Virginia No. 1	1.37	1.80	....	.43
West Virginia No. 2	1.92	1.90	.02	....
West Virginia No. 3	2.55	2.36	.19	....
West Virginia No. 4	2.26	2.18	.08	....
West Virginia No. 5	2.95	2.00	.95	....
West Virginia No. 6	2.19	1.92	.27	....
West Virginia No. 7	2.30	3.49	....	1.19
West Virginia No. 8	1.87	4.41	....	2.54
West Virginia No. 9	1.87	3.49	....	1.62
West Virginia No. 10	2.78	1.70	1.08	....
West Virginia No. 11	2.63	4.09	....	1.46
West Virginia No. 12	2.70	1.56	1.14	....
Total	60.54	83.04	3.87	26.37

Average excess of moisture in car samples, 26.37 ÷ 18 = 1.47 per cent.

Average excess of moisture in mine samples, 3.87 ÷ 8 = 0.48 per cent.

Coefficient of excess in car samples over the mine samples, 83.04 ÷ 60.54 = 1.37. Therefore, in sampling coals which run less than 5 per cent of moisture in the mine samples, the moisture in the commercial sample can be obtained with considerable probability by multiplying by the coefficient 1.37.

Although the figures given above show in a general way that the amount of moisture in carload lots of coal is little different from that contained in mine samples, there are slight variations in certain classes of coals, as noted above, which may be summarized as follows:

1. Lignites and lignitic coals are apt to show a greater percentage of moisture in the car than in the mine sample, but the percentage of gain is small.

2. Bituminous coals having a high moisture content (over 5 per cent) are apt to show less moisture in the car than in the mine sample, and the amount of loss is about 1½ per cent.

3. Bituminous and semibituminous coals with a small moisture content (less than 5 per cent) generally show a gain in moisture in the car sample, and the amount of gain is about 1½ per cent.

SULPHUR.

The variation in the percentage of sulphur in the mine and car samples is not great. Thirty-five samples show more sulphur in the car than in the mine sample, and 14 cases show less. The average amount gained in the 35 samples is 0.28 per cent, and the average loss in 14 samples is 0.33 per cent.

The general average of the sulphur in all analyses shows an increase in the car sample above that contained in the mine sample. This increase is therefore regarded as general and as due to more rigid exclusion of impurities in selecting the mine sample than the miners exercised in loading commercial coal. The coefficient of increase in the 50 samples at hand is 1.04. Therefore it is probable that in mine sampling for the purpose of determining the amount of sulphur in the commercial output of the mine it is necessary to multiply the amount in the mine sample by this coefficient of 1.04. When the per cent of sulphur is small, the amount to be added is insignificant and may be disregarded; but when the percentage is large, the increase is correspondingly great and should be taken into consideration.

ASH.

The greatest and most constant variation in the two classes of samples is in the ash. This was found to be so different in the car sample from what it was in the mine samples that allowance should be made for the difference in all careful sampling for commercial purposes.

In the 50 analyses compared 46 show a greater amount of ash in the car sample and 4 show a smaller amount than in the mine sample. This is so nearly unanimous that it may be regarded as a general rule. The total ash in the mine samples, as shown in the table, is 418.36 per cent. The total ash in the car samples is 545.37 per cent. 545.37 ÷ 418.36 = 1.3. If, therefore, the amount of ash in any given mine sample be multiplied by this coefficient, 1.3, the result will be approximately the amount of ash that may be expected in the commercial output of the mine.

As shown by the footings of the table, 46 samples show a gain of 130.94 per cent and 4 samples show a loss of 3.94 per cent. The net result is therefore a gain of 130.94 − 3.94 = 127 per cent. Since this is based on the analyses of 50 samples, the average gain in each case is 127 ÷ 50 = 2.54 per cent.

Since many of the cars were loaded with run-of-mine coal, it seems possible that this grade of coal is responsible for the great increase in the percentage of ash. If a separation is made on this basis it is found that of the 50 samples 29 consist of run-of-mine coal. The 29 samples of run-of-mine coal show an excess of only 2.31 per cent, or 0.23 per cent less than the average. Not only is the average excess of run-of-mine coal less than the general average for the whole, but also the 29 samples of run-of-mine coal include all of the cases (4 in number) in which the ash in the mine sample exceeds the ash in the car samples. From these figures it is obvious that the great excess of ash in the car samples was not due to the fact that the samples consisted of run-of-mine coal.

As might be expected, the personal element enters into the question of sampling to a considerable extent. In the present case A collected 23 samples, and the average per cent of ash in the car samples collected by him exceeds the average amount of ash in his mine samples by 2.4 per cent. B collected 16 samples, and the excess in his case amounts to 3.49 per cent. C collected 8 samples, and the excess is 1.66 per cent. D collected only 3 samples, but it is manifestly unsafe to generalize from so small an amount. With regard to the samples collected by A, B, and C, however, the results are apparently reliable, and they show that B was probably much more careful in excluding impurities from his mine samples than the others, and, consequently, the excess ash in his car samples is large. A attained about the happy medium, and his samples show an excess (2.4 per cent) only a little below the average excess (2.54 per cent) for the whole. C, on the other hand, has a much smaller excess, and in his mine sampling much more of the impurities were included than in the samples of A and B, but even in this case there was an appreciable excess in the car samples.

As stated on a previous page, the rules and regulations adopted for mine sampling in this work aimed to procure samples that would correspond with the commercial product of the mine. The results just given show that this end was not attained, and furthermore, they show that a strong personal element necessarily comes in where certain things are left to the judgment of the sampler. Such a system may be fairly satisfactory where one man does all the sampling, but this is seldom possible. In the light of the results obtained in this work, it seems to the writer that some arbitrary system that will eliminate the personal equation entirely is much better for general work, and therefore he would recommend the following method of mine sampling:

PROPOSED METHOD OF MINE SAMPLING.

1. Select a fresh face of coal and clean it of all powder stains and other impurities.

2. Cut a channel perpendicularly across the face of the coal from roof to floor, with the exceptions noted in 3, of such a size as to yield at least 5 pounds of coal per foot of thickness of coal bed—that is 5 pounds for a bed 1 foot thick, 10 pounds for a bed 2 feet thick, 20 pounds for a bed 4 feet thick, and so on.

3. All material encountered in such a cut should be included in the sample, except partings or binders over one-fourth inch in thickness, and except all lenses or concretions of sulphur or other impurities greater than 2 inches in maximum diameter and one-half inch in thickness.

4. The sample may be sent to the laboratory as it is cut, or it may at once be quartered down to about a quart sample. If it is quartered down it should be pulverized to about three-eighths inch, and after it has been thoroughly mixed it should be divided into quarters, and opposite quarters should be thrown away. The operation of mixing and quartering should be repeated until the desired sample is obtained. The operation of pulverizing and quartering should be done as rapidly as possible to prevent a serious change in the moisture content, and then the sample should be sealed in either a glass jar or screw-top can, bound with tire tape, and sent to the laboratory for analysis.

5. The analysis of such a sample will show the grade of coal that may be obtained by careful mining and picking. In the great majority of cases the sulphur and ash in the commercial output of the mine will exceed the amount obtained from the sample, but this can be approximated by multiplying by certain coefficients. The coefficients determined in the work of last year will not be strictly applicable, since the sampling was not done under this system, but they are approximately correct and can be used until more accurate coefficients are determined. When sufficient data is at hand it seems possible that specific coefficients may be determined for certain fields—that is to say, a coefficient may be fixed for the Appalachian field, another coefficient for the eastern interior field, etc., and finally coefficients may be determined for local subdivisions of the larger fields, or for certain beds of coal within that field.

6. All descriptions of samples should state definitely how the samples were procured, so that the reader may judge for himself the value of the results obtained, and where analyses are recalculated the coefficients of increase or decrease should be given, together with the authority for using this coefficient or the data from which it has been determined.

CLASSIFICATION OF COALS.

By Marius R. Campbell.

INTRODUCTION.

NEED OF A SCHEME OF CLASSIFICATION.

The classes of coals recognized in this country at the present time are various. They depend largely upon physical characteristics rather than upon chemical composition, and consequently they can not be accurately defined. The divisions into anthracite, semianthracite, and semibituminous are fairly satisfactory, but the term bituminous embraces such a variety of coals that it is of little value, and the term lignite is so loosely applied that it has little or no place in a scientific classification.

At present there is no way of accurately defining the various classes of coal, because no adequate scheme of classification which applies to lignites as well as to bituminous coal and anthracite has been proposed. The object of this paper is to propose such a scheme. The data upon which it is based were obtained during the past year by Prof. N. W. Lord, in charge of the chemical laboratory of the United States Geological Survey coal-testing plant at the Louisiana Purchase Exposition, St. Louis.

CLASSIFICATIONS PREVIOUSLY PROPOSED.

All of the classifications of coals that were proposed prior to 1877 were based either on physical characteristics or on proximate analyses, including all of the impurities. These schemes are illogical and highly unsatisfactory, for the physical properties of a coal give little indication of its true composition; and impurities, such as ash and sulphur, are largely the results of accidents during the deposition of the coal and are not directly related to its fuel value.

PENNSYLVANIA CLASSIFICATION.

The first serious attempt in this country to establish a scientific classification of coals was made by Persifor Frazer, jr., while engaged in work as assistant geologist on the Second Geological Survey of Pennsylvania. The results of his investigations along this line were first presented to the American Institute of Mining Engineers at their Wilkesbarre meeting in May, 1877. They were published in Volume VI of the Transactions of the Institute, and also appeared in Report MM of the Second Geological Survey, in 1879. This classification was based on fuel ratios, and fuel ratio was described as the quotient of the fixed carbon divided by the volatile combustible matter. Fuel ratios were calculated for a great many Pennsylvania coals, and after a careful comparison with the coals themselves the following classification was adopted:

Classification of Pennsylvania coals.

	Fuel ratios.
Anthracite	100 to 12
Semianthracite	12 to 8
Semibituminous	8 to 5
Bituminous	5 to 0

This scheme worked very satisfactorily for the Pennsylvania coals, but the selection of the name semibituminous was unfortunate, since its application is directly at variance with the true meaning of the word.

The great advantage of the scheme over those previously used is that it is based on certain definite constituents of the coal, and these constituents, in a general way, determine the fuel value of the coal; but when an attempt was made to apply this classification to the various coals of the United States it was found to be inapplicable.

It failed in two particulars, (1) in grouping all of the coals with a fuel ratio of 5 or less into one class, and (2) in making no provision for lignite, which now has become the chief source of fuel in many parts of the West.

The failure to define lignite is generally regarded as the more serious defect, but, in the opinion of the writer, this is no more serious than that of including in one great group all of the bituminous coals of the country. This plan places the low-grade coals of Iowa and Missouri in the same class, and, inferentially, gives them much the same value as the New River and Kanawha River coals of West Virginia and the great Pittsburg bed of Pennsylvania. This is manifestly unjust, and it is enough to condemn the scheme without reference to the lignites, which have no place in the classification except with the bituminous coals.

CLASSIFICATION OF LIGNITES.

One of the characteristic features of lignite is the large percentage of moisture that it contains, and some geologists have proposed to use this fact as a basis of separation between it and low-grade bituminous coal. Collier[a] proposed a moisture content of 10 per cent as the basis of separation between bituminous coal and lignite. According to his scheme all coals having a percentage of moisture equal to or greater than 10 should be considered lignite, and all those having a percentage less than 10 should be considered bituminous.

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[a] Coal resources of the Yukon, Alaska: Bull. U. S. Geol. Survey No. 218, 1903.

The results obtained at St. Louis during the past summer clearly show that this is not a safe basis for a scientific division into these two great classes of coal, for the reason that many of the well-recognized bituminous coals of the Mississippi Valley contain a greater amount of moisture than 10 per cent, and it would be manifestly incorrect to class them as lignite, or even lignitic coal.

The results above referred to show that 3 samples of Illinois coal, 2 samples of Indiana coal, 5 samples of Iowa coal, 2 samples of Missouri coal, and 1 sample of Montana coal contain more than 10 per cent of moisture in the sample as received from the mines or from the carload after shipment to St. Louis. Moreover, three of the above-named samples showed more than 10 per cent of moisture after air drying until the weight of the sample had become fairly constant. On the other hand, samples of black lignite from New Mexico contain 9.13, 9.68, and 9.40 per cent of moisture, the samples having been cut in the mine and at once sealed in air-tight cans before they were sent to the laboratory for analysis. These facts show conclusively that the moisture content is not a feature upon which a classification can be based.

DISCUSSION OF OTHER SCHEMES OF CLASSIFICATION.

The analytical work done at the coal-testing laboratory at St. Louis affords an excellent opportunity for testing various schemes of classification. Proximate and ultimate analyses were made of 56 samples of coal, representing the classes of brown lignite, black lignite, low-grade bituminous, high-grade bituminous, semibituminous, and anthracite coal.

FUEL RATIO.

In order to test the possibility of using the various constituents of the coal, as determined by both proximate and ultimate analyses, as a basis for a scheme of classification, a number of tables have been prepared. The first table shows the samples classed according to their fuel ratios (Pennsylvania system):

TABLE I.—*Classification of coals according to fuel ratios.*

Name of sample.	Name of bed or field.	Fuel ratio.
Pennsylvania No. 3	Anthracite	10.22
Arkansas No. 5	Spadra bed	5.75
Arkansas No. 2	Huntington bed	4.53
West Virginia No. 11	Pocahontas bed	4.19
West Virginia No. 12	Pocahontas field	4.12
West Virginia No. 10	do	4.04
Arkansas No. 1	Huntington bed	3.82
West Virginia No. 7	New River field	3.58
Arkansas No. 3	Huntington bed	3.43
West Virginia No. 6	New River field	3.34
West Virginia No. 4	Upper Freeport bed	2.16
West Virginia No. 9	Kanawha field	2.12
West Virginia No. 5	Upper Freeport bed	2.05
Pennsylvania No. 4	Connellsville field	2.03
West Virginia No. 3	Upper Freeport bed	1.93
West Virginia No. 8	Kanawha field	1.83
Illinois No. 3	Marion County	1.72
Kansas No. 5	Weir-Pittsburg bed	1.70
Alabama No. 1	Warrior field	1.67
Alabama No. 2	do	1.56
Kentucky No. 1	Eastern field	1.56
Kansas No. 1	Weir-Pittsburg bed	1.51
Kansas No. 2	do	1.49
West Virginia No. 1	Pittsburg bed	1.49
Iowa No. 1	Wapello County	1.47
Illinois No. 6	Montgomery County	1.45
Indian Territory No. 1	Henryetta bed	1.40
Illinois No. 4	Belleville field	1.37
Iowa No. 5	Lucas County	1.36
Indian Territory No. 2	Hartshorne bed	1.34
New Mexico No. 1	Black lignite, Gallup field	1.33
Kentucky No. 4	Western field	1.29
Indian Territory No. 3	McAlester bed	1.28
Kansas No. 4	Atchison field	1.27
Kentucky No. 3	Western field	1.27
West Virginia No. 2	Pittsburg bed	1.25
Indiana No. 1	Sullivan County	1.22
Kentucky No. 2	Western field	1.19
Montana No. 1	Red Lodge	1.17
Colorado No. 1	Black lignite, Boulder field	1.16
Indian Territory No. 4	McAlester bed	1.16
Missouri No. 1	Rich Hill field	1.15

TABLE I.—*Classification of coals according to fuel ratios*—Continued.

Name of sample.	Name of bed or field.	Fuel ratio.
Indiana No. 2	Warrick County	1.14
Iowa No. 2	Marion County	1.13
Missouri No. 2	Bevier field	1.13
Iowa No. 4	Appanoose County	1.11
New Mexico No. 2	Black lignite, Gallup field	1.09
Illinois No. 1	Belleville field	1.06
North Dakota No. 2	Brown lignite, Williston field	1.06
Wyoming No. 1	Black lignite, Sheridan field	1.05
Texas No. 2	Brown lignite, Wood County	1.02
Wyoming No. 2	Cambria field	1.00
Missouri No. 4	Morgan County	.99
Iowa No. 3	Polk County	.95
North Dakota No. 1	Brown lignite, Lehigh field	.87
Texas No. 1	Brown lignite, Houston County	.68

The table given above shows clearly that the figures denoting fuel ratios are not satisfactory as a basis of classification. So far as the upper part of the column is concerned it works perfectly, the anthracite being sharply differentiated from the semibituminous coals which follow; but in the lower part of the column there is great confusion and absolutely no indication of a line of separation between the bituminous coals and lignites. The conclusion, therefore, is inevitable that for any general scheme of classification applicable to the various grades of coal in this country, fuel ratios are not adequate and must be discarded.

FIXED CARBON.

In this connection it may be interesting to compare the percentages of fixed carbon, as shown by the proximate analyses. In Table II the ash is classed as an impurity and the percentages are obtained by regarding the moisture, volatile combustible matter, and fixed carbon of the analysis of the air-dried sample as 100 per cent:

TABLE II.—*Classification of coals according to content of fixed carbon.*

Name of sample.	Name of bed or field.	Percentage of fixed carbon.
Pennsylvania No. 3	Anthracite	88.82
Arkansas No. 5	Spadra bed	83.95
Arkansas No. 3	Huntington bed	81.25
West Virginia No. 11	Pocahontas bed	80.00
West Virginia No. 12	Pocahontas field	79.94

TABLE II.—*Classification of coals according to content of fixed carbon*—Continued.

Name of sample.	Name of bed or field.	Percentage of fixed carbon.
West Virginia No. 10	Pocahontas field	79.61
Arkansas No. 1	Huntington bed	78.19
West Virginia No. 7	New River field	77.56
Arkansas No. 3	Huntington bed	76.71
West Virginia No. 6	New River field	76.42
West Virginia No 4	Upper Freeport bed	67.57
West Virginia No. 9	Kanawha field	67.24
Pennsylvania No. 4	Connellsville field	67.05
West Virginia No. 5	Upper Freeport bed	66.77
West Virginia No. 3	do	65.14
West Virginia No. 8	Kanawha field	63.61
Kansas No. 5	Weir-Pittsburg bed	61.62
Alabama No. 1	Warrior field	61.49
Kentucky No. 1	Eastern field	59.73
Alabama No. 2	Warrior field	59.15
West Virginia No. 1	Pittsburg bed	59.13
Illinois No. 3	Marion County	59.00
Kansas No. 2	Weir-Pittsburg bed	58.28
Kansas No. 1	do	57.58
Indian Territory No. 2	Hartshorne bed	56.15
Indian Territory No. 1	Henryetta bed	55.84
Iowa No. 1	Wapello County	55.72
Illinois No. 6	Montgomery County	55.66
West Virginia No. 2	Pittsburg bed	54.83
Kentucky No. 4	Western field	54.79
Indian Territory No. 3	McAlester bed	53.90
Kansas No. 4	Atchison field	53.56
Kentucky No. 3	Western field	52.35
Iowa No. 5	Lucas County	51.50
Missouri No. 1	Rich Hill field	51.21
Kentucky No. 2	Western field	51.06
Indian Territory No. 4	McAlester bed	50.69
New Mexico No. 1	Black lignite, Gallup field	50.49
Illinois No. 4	Belleville field	50.26
Indiana No. 1	Sullivan County	49.51
Indiana No. 2	Warrick County	49.44
Montana No. 1	Red Lodge	48.47
Wyoming No. 2	Cambria field	48.11
Illinois No. 1	Belleville field	47.61
Missouri No. 2	Bevier field	47.19
Missouri No. 4	Morgan County	46.97

TABLE II.—*Classification of coals according to content of fixed carbon*—Continued.

Name of sample.	Name of bed or field.	Percentage of fixed carbon.
New Mexico No. 2	Black lignite, Gallup field	46.83
Iowa No. 4	Appanoose County	46.57
Iowa No. 2	Marion County	46.56
Iowa No. 3	Polk County	46.16
Colorado No. 1	Black lignite, Boulder field	45.96
Texas No. 2	Brown lignite, Wood County	44.47
North Dakota No. 2	Brown lignite, Williston field	42.33
Wyoming No. 1	Black lignite, Sheridan field	41.55
North Dakota No. 1	Brown lignite, Lehigh field	38.30
Texas No. 1	Brown lignite, Houston County	34.06

Since the carbon of coal is its most predominant element, a classification based on the fixed carbon naturally agrees very closely with the fuel ratios where the volatile combustible matter is small; hence in the upper part of the column the arrangement is fairly satisfactory, but in the lower part, although low-grade bituminous coals occur near the bottom of the series, two of the lignites occur considerably above them, and consequently the classification is not satisfactory.

CALORIFIC VALUE.

The tables just given show that the data supplied by proximate analyses can not be used in a scientific classification of coals. The only other simple method is by means of calorific values determined in a calorimeter. At the laboratory of the testing plant these were determined in a Mahler bomb calorimeter. They have been recalculated on a basis of pure coal—that is, by excluding the ash as so much inert matter—and the results are given in Table III:

TABLE III.—*Classification of coals according to calorific value.*

Name of sample.	Name of bed or field.	B. T. U.[a]
West Virginia No. 10	Pocahontas field	15,927
West Virginia No. 12	do	15,833
West Virginia No. 11	Pocahontas bed	15,786
West Virginia No. 6	New River field	15,743
West Virginia No. 7	do	15,647
Pennsylvania No. 4	Connellsville field	15,506
Arkansas No. 3	Huntington bed	15,482
West Virginia No. 4	Upper Freeport bed	15,440
West Virginia No. 9	Kanawha field	15,417

[a] British thermal units.

TABLE III.—*Classification of coals according to calorific value*—Continued.

Name of sample.	Name of bed or field.	B. T. U.
Arkansas No. 2	Huntington bed	15,399
West Virginia No. 5	Upper Freeport bed	15,396
Arkansas No. 1	Huntington bed	15,393
West Virginia No. 3	Upper Freeport bed	15,325
West Virginia No. 8	Kanawha field	15,277
Arkansas No. 5	Spadra bed	15,270
West Virginia No. 1	Pittsburg bed	15,129
West Virginia No. 2	....do	15,048
Kentucky No. 1	Eastern field	14,984
Pennsylvania No. 3	Anthracite	14,906
Alabama No. 1	Warrior field	14,833
Kansas No. 5	Weir-Pittsburg bed	14,795
Indian Territory No. 2	Hartshorne bed	14,624
Kansas No. 2	Weir-Pittsburg bed	14,535
Kentucky No. 4	Western field	14,394
Kansas No. 1	Weir-Pittsburg bed	14,280
Missouri No. 4	Morgan County	14,276
Alabama No. 2	Warrior field	14,232
Kansas No. 4	Atchison field	14,120
Indian Territory No. 1	Henryetta bed	14,076
Indian Territory No. 3	McAlester bed	14,054
Missouri No. 1	Rich Hill field	13,997
Kentucky No. 2	Western field	13,836
Kentucky No. 3	....do	13,702
Illinois No. 3	Marion County	13,689
Iowa No. 1	Wapello County	13,646
Iowa No. 2	Marion County	13,471
Iowa No. 3	Polk County	13,443
Indiana No. 2	Warrick County	13,340
Wyoming No. 2	Cambria field	13,331
Illinois No. 1	Belleville field	13,268
Indiana No. 1	Sullivan County	13,232
Indian Territory No. 4	McAlester bed	13,151
Illinois No. 6	Montgomery County	13,085
Iowa No. 5	Lucas County	12,711
Iowa No. 4	Appanoose County	12,683
Missouri No. 2	Bevier field	12,638
New Mexico No. 2	Black lignite, Gallup field	12,629
Illinois No. 4	Belleville field	12,469
New Mexico No. 1	Black lignite, Gallup field	12,309
Montana No. 1	Red Lodge	12,139

TABLE III.—*Classification of coals according to calorific value*—Continued.

Name of sample.	Name of bed or field.	B. T. U.
Colorado No. 1	Black lignite, Boulder field	11,525
North Dakota No. 1	Brown lignite, Lehigh field	11,465
Texas No. 1	Brown lignite, Houston County	10,990
Texas No. 2	Brown lignite, Wood County	10,881
Wyoming No. 1	Black lignite, Sheridan field	10,876
North Dakota No. 2	Brown lignite, Williston field	10,174

The results shown by the table are fairly satisfactory, so far as the lower part of the scale is concerned. The lignites are more nearly grouped than in any of the preceding tables, but there is still some uncertainty about the dividing line between them and the bituminous coals. The scheme of classification fails in the upper part, as many of the bituminous coals are of higher calorific value than the best grades of anthracite.

HYDROGEN.

As the results obtained by proximate analyses and the determination of calorific values afford no basis for classification, the only recourse is to the elements shown in an ultimate analysis. Heretofore ultimate analyses have not been regarded as important and few have been made. All coals, however, that were tested at St. Louis during the past season were analyzed in this manner, and the results afford a fairly satisfactory mass of evidence upon which to base conclusions. In every case the analysis of the air-dried sample is used, and the percentages are recalculated on the basis of excluding ash and sulphur. The classification based on percentages of hydrogen is as follows:

TABLE IV.—*Classification of coals according to content of hydrogen.*

Name of sample.	Name of bed or field.	Percentage of hydrogen.
Pennsylvania No. 3	Anthracite	3.39
Arkansas No. 5	Spadra bed	4.36
West Virginia No. 11	Pocahontas bed	4.58
Arkansas No. 2	Huntington bed	4.65
Arkansas No. 1	do	4.66
West Virginia No. 7	New River field	4.67
Arkansas No. 3	Huntington bed	4.68
West Virginia No. 12	Pocahontas field	4.72
West Virginia No. 10	do	4.83
West Virginia No. 6	New River field	4.99

TABLE IV.—*Classification of coals according to content of hydrogen*—Continued.

Name of sample.	Name of bed or field.	Percentage of hydrogen.
West Virginia No. 4	Upper Freeport bed	5.35
West Virginia No. 5	do	5.38
West Virginia No. 9	Kanawha field	5.46
Alabama No. 2	Warrior field	5.54
Pennsylvania No. 4	Connellsville field	5.54
West Virginia No. 3	Upper Freeport bed	5.54
Kentucky No. 4	Western field	5.62
West Virginia No. 8	Kanawha field	5.62
West Virginia No. 1	Pittsburg bed	5.67
Illinois No. 3	Marion County	5.68
Kentucky No. 1	Eastern field	5.68
Indian Territory No. 3	McAlester bed	5.70
Alabama No. 1	Warrior field	5.73
Indian Territory No. 2	Hartshorne bed	5.74
West Virginia No. 2	Pittsburg bed	5.75
Kansas No. 5	Weir-Pittsburg bed	5.81
Indian Territory No. 1	Henryetta bed	5.86
Indian Territory No. 4	McAlester bed	5.86
Iowa No. 1	Wapello County	5.88
Texas No. 2	Brown lignite, Wood County	5.90
Kansas No. 1	Weir-Pittsburg bed	5.95
Illinois No. 6	Montgomery County	6.04
Montana No. 1	Red Lodge	6.04
North Dakota No. 2	Brown lignite, Williston field	6.05
Kansas No. 2	Weir-Pittsburg bed	6.06
North Dakota No. 1	Brown lignite, Lehigh field	6.08
Kentucky No. 3	Western field	6.12
Kentucky No. 2	do	6.13
Illinois No. 4	Belleville field	6.14
Wyoming No. 2	Cambria field	6.17
Colorado No. 1	Black lignite, Boulder field	6.18
Illinois No. 1	Belleville field	6.21
New Mexico No. 1	Black lignite, Gallup field	6.21
Indiana No. 1	Sullivan County	6.22
Iowa No. 2	Marion County	6.22
Indiana No. 2	Warrick County	6.24
Missouri No. 1	Rich Hill field	6.26
Iowa No. 4	Appanoose County	6.32
Iowa No. 3	Polk County	6.35
New Mexico No. 2	Black lignite, Gallup field	6.35

TABLE IV.—*Classification of coals according to content of hydrogen*—Continued.

Name of sample	Name of bed or field.	Percentage of hydrogen.
Kansas No. 4	Atchison field	6.37
Missouri No. 2	Bevier field	6.41
Iowa No. 5	Lucas County	6.44
Wyoming No. 1	Black lignite, Sheridan field	6.44
Missouri No. 4	Morgan County	6.46
Texas No. 1	Brown lignite, Houston County	6.62

The results are fairly satisfactory as regards the highly carbonized coals, but even in this part of the column the difference between Pennsylvania anthracite and the semibituminous coals of Arkansas and West Virginia is not very well marked. The greatest difficulty, however, in using hydrogen as a basis for classification is in the lower grades of bituminous coals and lignites. As shown in the table, lignites are very regularly distributed throughout a range of from 5.90 per cent to 6.62 per cent, the last in the table. It is manifest that the percentage of hydrogen is of no use for purposes of classification.

CARBON.

Classification according to carbon content is much better, as is shown by Table V.

TABLE V.—*Classification of coals according to content of carbon.*

Name of sample.	Name of bed or field.	Percentage of carbon.
Pennsylvania No. 3	Anthracite	90.73
West Virginia No. 10	Pocahontas field	90.63
West Virginia No. 12	.....do	90.55
Arkansas No. 2	Huntington bed	90.18
Arkansas No. 5	Spadra bed	90.11
West Virginia No. 11	Pocahontas bed	89.95
West Virginia No. 6	New River field	88.72
Arkansas No. 1	Huntington bed	88.16
West Virginia No. 7	New River field	87.95
Arkansas No. 3	Huntington bed	87.89
Pennsylvania No. 4	Connellsville field	87.10
West Virginia No. 4	Upper Freeport bed	86.26
West Virginia No. 5	.....do	85.97
West Virginia No. 3	.....do	85.95
West Virginia No. 8	Kanawha field	85.86
West Virginia No. 9	.....do	85.86

TABLE V.—*Classification of coals according to content of carbon*—Continued.

Name of sample.	Name of bed or field.	Percentage of carbon.
West Virginia No. 1	Pittsburg bed	84.45
Kansas No. 5	Weir-Pittsburg bed	84.25
West Virginia No. 2	Pittsburg bed	84.01
Kansas No. 2	Weir-Pittsburg bed	83.81
Alabama No. 1	Warrior field	83.29
Kentucky No. 1	Eastern field	83.03
Kansas No. 1	Weir-Pittsburg bed	82.68
Kentucky No. 4	Western field	82.38
Kansas No. 4	Atchison field	82.27
Indian Territory No. 2	Hartshorne bed	82.07
Missouri No. 4	Morgan County	81.22
Missouri No. 1	Rich Hill field	80.99
Indian Territory No. 3	McAlester bed	80.17
Alabama No. 2	Warrior field	80.10
Indian Territory No. 1	Henryetta bed	79.69
Iowa No. 1	Wapello County	78.96
Iowa No. 3	Polk County	78.08
Kentucky No. 2	Western field	77.85
Illinois No. 3	Marion County	77.67
Iowa No. 2	do	77.59
Kentucky No. 3	Western field	77.52
Indiana No. 2	Warrick County	76.89
Indian Territory No. 4	McAlester bed	76.55
Illinois No. 1	Belleville field	75.59
Wyoming No. 2	Cambria field	75.15
Illinois No. 6	Montgomery County	74.86
Indiana No. 1	Sullivan County	74.39
Iowa No. 4	Appanoose County	72.86
Missouri No. 2	Bevier field	72.68
Iowa No. 5	Lucas County	72.14
New Mexico No. 2	Black lignite, Gallup field	71.35
Illinois No. 4	Belleville field	71.18
New Mexico No. 1	Black lignite, Gallup field	69.74
Montana No. 1	Red Lodge	69.41
Colorado No. 1	Black lignite, Boulder field	65.71
Texas No. 2	Brown lignite, Wood County	64.05
Texas No. 1	Brown lignite, Houston County	61.90
Wyoming No. 1	Black lignite, Sheridan field	61.76
North Dakota No. 1	Brown lignite, Lehigh field	61.43
North Dakota No. 2	Brown lignite, Williston field	59.54

In a general way this classification is satisfactory, the coals showing a fairly regular decrease in amount of carbon from Pennsylvania anthracite at the top to brown lignite of North Dakota at the bottom, but the degree of separation between the anthracite and the semibituminous coals is not marked and seemingly not so great as the real difference between those coals would seem to demand. When the table is examined in detail many points seem objectionable; for instance, Arkansas No. 5 is a semibituminous coal which, according to the old scheme, should certainly follow the anthracite in the list, but instead it occurs in fourth place below it. West Virginia No. 11 (Pocahontas) should be in second place below the anthracite, but it occurs in the fifth place. Also the lignites are not easily distinguished from some of the bituminous coals, and in fact some of the lignites occur above Illinois No. 4, which is a well-recognized bituminous coal.

CARBON-HYDROGEN RATIO.

The schemes of classification so far given take account of all the fuel elements of the coal or all the elements upon which a classification can logically be based.

The percentage of carbon forms the most satisfactory basis of classification so far tried, but carbon is only one of the important fuel elements of coal. Hydrogen is almost equally valuable, yet, as has been shown in a previous table, this, taken alone, does not afford a satisfactory basis.

The increase in the value of coal from the grade of brown lignite to that of anthracite involves both carbon and hydrogen; it depends upon an increase (or at least no diminution) in the amount of the former and a direct loss of the latter. For this reason the ideal classification should take account of both elements.

Since the percentage of hydrogen decreases as the percentage of carbon increases the two elements should not be combined by addition or by multiplication, for both of these processes would tend to equalize the results, and this is undesirable for purposes of classification. Subtraction or division, therefore, must be used to express the desired relation. The latter seems to be the most satisfactory, and therefore a table has been prepared showing these quotients or ratios.

TABLE VI.—*Classification of coals according to carbon-hydrogen ratios.*

Name of sample.	Name of bed or district.	Carbon-hydrogen ratio.
	Groups A, B, and C.	
Pennsylvania No. 3	Anthracite	26.7
	Group D.	
	Group E.	
Arkansas No. 5	Spadra bed	20.7
	Group F.	
West Virginia No. 11	Pocahontas bed	19.6
Arkansas No. 2	Huntington bed	19.3
West Virginia No. 12	Pocahontas field	19.2
Arkansas No. 1	Huntington bed	18.9
Arkansas No. 3	.....do	18.8
West Virginia No. 7	New River field	18.8
West Virginia No. 10	Pocahontas field	18.7
West Virginia No. 6	New River field	17.8
	Group G.	
West Virginia No. 4	Upper Freeport bed	16.1
West Virginia No. 5	.....do	15.9
Pennsylvania No. 4	Connellsville field	15.7
West Virginia No. 9	Kanawha field	15.7
West Virginia No. 3	Upper Freeport bed	15.5
West Virginia No. 8	Kanawha field	15.3
West Virginia No. 1	Pittsburg bed	14.7
Kentucky No. 1	Eastern field	14.6
Kentucky No. 4	Western field	14.6
Alabama No. 1	Warrior field	14.5
Alabama No. 2	.....do	14.5
Kansas No. 5	Weir-Pittsburg bed	14.5
West Virginia No. 2	Pittsburg bed	14.4
	Group H.	
Indian Territory No. 2	Hartshorne bed	14.3
Indian Territory No. 3	McAlester bed	14.1
Kansas No. 1	Weir-Pittsburg bed	13.9
Kansas No. 2	.....do	13.8
Illinois No. 3	Marion County	13.7
Indian Territory No. 1	Henryetta bed	13.6
Iowa No. 1	Wapello County	13.4
Indian Territory No. 4	McAlester bed	13.1
Kansas No. 4	Atchison field	12.9
Missouri No. 1	Rich Hill field	12.9

TABLE VI.—*Classification of coals according to carbon-hydrogen ratios*—Continued.

Name of sample.	Name of bed or district.	Carbon-hydrogen ratio.
	Group H—Continued.	
Kentucky No. 2	Western field	12.7
Kentucky No. 3	do	12.6
Missouri No. 4	Morgan County	12.6
	Group I.	
Iowa No. 2	Marion County	12.4
Illinois No. 6	Montgomery County	12.3
Indiana No. 2	Warrick County	12.3
Iowa No. 3	Polk County	12.3
Illinois No. 1	Belleville field	12.2
Wyoming No. 2	Cambria field	12.2
Indiana No. 1	Sullivan County	11.9
Illinois No. 4	Belleville field	11.6
Iowa No. 4	Appanoose County	11.5
Montana No. 1	Red Lodge	11.5
Missouri No. 2	Bevier field	11.3
Iowa No. 5	Lucas County	11.2
	Group J.	
New Mexico No. 1	Black lignite, Gallup field	11.2
New Mexico No. 2	do	11.2
Texas No. 2	Brown lignite, Wood County	10.9
Colorado No. 1	Black lignite, Boulder field	10.6
North Dakota No. 1	Brown lignite, Lehigh field	10.1
North Dakota No. 2	Brown lignite, Williston field	9.8
Wyoming No. 1	Black lignite, Sheridan field	9.6
Texas No. 1	Brown lignite, Houston County	9.4
	Group K.	
Peat		9.1

In considering schemes of classification it must be remembered that our present knowledge of the chemical composition of coal is very imperfect, and that any scheme which may be proposed depends to a certain extent on unknown or little-understood factors. For this reason any scheme must be regarded as provisional.

The points of greatest weakness are our ignorance of the character of the volatile combustible matter and also of the form or nature of what is usually called moisture. A few experiments made at St. Louis seem to indicate that something more than moisture frequently passes off of coal at ordinary temperatures, and hence the moisture, as shown in the analyses, probably includes some of the lighter hydrogen compounds. Also it is doubtful whether we should regard water as a nonfuel element, for in many cases it is dissociated and its hydrogen becomes available for fuel purposes.

Many of these questions are to be investigated at St. Louis during the present year, and it is hoped that some additional light may be thrown upon them. It is possible that the tests and experiments made there may necessitate some changes in the figures given in the accompanying tables, but it is probable that the net result will be a slight modification only, and will not directly contravene the conclusions herein reached.

So far as the writer is acquainted with the character and fuel value of the coals tested the classification just given seems to be almost ideal. It is not only correct in a general way, but in detail it seems to fit almost every case. True, the separation between bituminous coal and lignite is not sharp and distinct, but it is highly probable that there is no sharp distinction between these two classes, and that the facts are best represented by a merging of values, as shown in the table. The writer therefore takes this opportunity of proposing provisionally the carbon-hydrogen ratio as the basis of a new scientific classification of coals which is applicable to all, from the highest class of anthracite to the lowest grade of brown lignite and peat.

POSSIBLE EXCEPTIONS.

The evidence upon which this classification is based is not sufficient for its final acceptance. It is quite possible that it may fail in some cases, but it is put forward at this time in a tentative way to invite discussion and investigation. The coals so far examined are of diverse character and include most of the various kinds known in this country. Owing to the low percentage of fixed carbon and the relatively high percentage of volatile combustible matter in cannel coal, the ratio between the total carbon and the hydrogen may possibly be so low that, according to this scheme, it will fall below its normal position. This, however, is purely theoretical, and it can be decided only by actual trial when the ultimate analysis of a typical cannel coal is available.

DIVISION INTO GROUPS.

Assuming that the arrangement is correct, the next step is a division into groups which will have sufficient practical value to be adopted. Considering values in a broad way there are opportunities and demands for a greater number of classes than are recognized at the present time. For instance, there should be two classes of anthracite coal instead of the one in use to-day, and these fall below graphite, which necessarily is the highest group in the series. The classes of semianthracite and semibituminous are probably good and should be retained, but not with the same names nor the same definitions. The great group of bituminous coals should be divided into at least four classes, which should separate the low-grade fuels of the Mississippi Valley from the high-class coals of the Appalachian region. Not enough is known about the lignites to say whether it will be possible to separate them into classes. Chemically they are closely related, but physically they are divisible into two groups, black and brown lignite; yet the scheme herein proposed does not recognize this difference. The lowest group is that including peat, and this seems to be clearly separated from the lowest grade of brown lignite.

The writer is not prepared to propose names for these groups; in fact, for preliminary discussion it seems best to designate them arbitrarily by the letters of the alphabet, as group A, group B, etc.

Proposed groups of coal and allied substances.

		Carbon-hydrogen ratios.
Group A:	Graphite	∞ to (?)
Group B	Anthracite	(?) to 30 (?)
Group C		30 (?) to 26 (?)
Group D:	Semianthracite	26 (?) to 23 (?)
Group E:	Semibituminous	23 (?) to 20
Group F	Bituminous	20 to 17
Group G		17 to 14.4
Group H		14.4 to 12.5
Group I		12.5 to 11.2
Group J:	Lignite	11.2 to 9.3 (?)
Group K:	Peat	9.3 (?) to (?)
Group L:	Wood (cellulose)	7.2

Groups A, B, C, D, and E.—As little work was done at the testing plant on anthracite coal, and as all the analyses made by the Second Geological Survey of Pennsylvania were proximate analyses, little material is available for determining the limits of these groups, and the figures given must be regarded as provisional only and subject to change when a greater number of ultimate analyses have been made.

Groups F, G, H, and I.—These groups embrace what generally are considered bituminous coals. Group F includes Pocahontas coal, the high-grade Arkansas coals west of the Spadra district, and New River coals. Group G includes Upper Freeport and Pittsburg coals of northern West Virginia, Kanawha Valley coals, high-grade Kentucky coals, and Alabama coals. Group H includes all Indian Territory coals, all Kansas coals, high-grade Illinois, Iowa, and Missouri coals, and second-grade Kentucky coals. Group I includes the great majority of Iowa, Illinois, and Missouri coals, Indiana coals, and some bituminous coals from Wyoming and Montana.

Groups J, K, and L.—Group J includes all of the lignites, both black and brown, that were tested. Group K is limited to peat, and it is based entirely upon one analysis obtained from outside sources, and group L is wood, the lowest group in the series.

RÉSUMÉ.

The results obtained in this investigation may be summed up as follows:

1. Fuel ratios, or any of the components of coal as determined by a proximate analysis, are worthless for purposes of classification except for highly carbonized fuel, such as anthracite, semianthracite, and semibituminous coal.

2. Calorific values are equally unsuited, but in this case the failure is particularly well marked in the upper part of the coal column.

3. Of the elements shown by an ultimate analysis, carbon is the only one at all satisfactory, and this fails in detail.

4. Carbon-hydrogen ratios form a satisfactory basis for classification. This scheme applies perfectly to all samples of fuel tested at St. Louis during the past year, and these include representatives of all classes, except cannel coal and some classes of anthracite and semianthracite coal.

5. Twelve classes of coals and allied compounds are suggested, as shown in the table on page 172.

WORK OF THE CHEMICAL LABORATORY.

By N. W. Lord.

INTRODUCTION.

The chemical laboratory of the fuel-testing plant was designed for making analyses of all the fuel tested. It was also charged with such other analytical work, with the exception of the gas analysis, as was required in connection with the tests. As the time for planning the work and equipping the laboratory was very limited, and as the amount of the routine work to be done in the short time assigned to the tests was very great, it was impossible to undertake any systematic investigation of methods of analysis. Such tests and experiments as the time permitted were carried on in connection with the regular work and will be discussed in this report.

The laboratory was under the immediate charge and supervision of Prof. E. E. Somermeier, assistant professor of metallurgy at the Ohio State University; his assistants were Mr. F. M. Stanton, Mr. John Crawford, jr., and Mr. G. A. Burrell. The collecting of the samples at the testing plant was attended to largely by Mr. F. A. Bryan.

The laboratory occupied a space of 24 by 30 feet in the metal pavilion southwest of the mines and metallurgy building. Of the space assigned to the work 224 square feet were occupied as a sampling room, 120 square feet as a calorimeter room, and the remainder (376 square feet) as an analytical laboratory.

SAMPLING.

APPARATUS USED.

The equipment for sampling at the laboratory was a "chipmunk" jaw crusher and a Calkins automatic sampler, furnished by the F. W. Braun Company, of Los Angeles, Cal.; a pair of 10-inch crushing rolls, and a bucking plate and muller.

The machinery was operated by a 2-horsepower direct-current motor, furnished by the Westinghouse Electric and Manufacturing Company, of Pittsburg.

Samples up to 1 kilogram were weighed on a Harvard trip scale, larger samples (up to 20 kilograms) on a No. 80 Troemner solution scale.

The jaw crusher would take material from 1½ to 2 inches in size and reduce it to about one-fourth inch, at a rate of about 200 to 300 pounds per hour. The crushing rolls reduced the material from about one-fourth to one-twentieth of an inch at the rate of from 100 to 200 pounds per hour. The final grinding was done on the bucking plate.

In addition to the above, the laboratory was equipped with the necessary trays, sieves, spatulas, brushes, etc., for handling the samples.

COLLECTION OF SAMPLES.

MINE SAMPLES.

Samples came from the mines to the laboratory by mail in sealed galvanized-iron cans holding about 3 pounds. This represented a much larger sample, carefully taken at the mine and reduced by breaking down, mixing, and quartering as described on page 33 in the report on the field work.

SAMPLES FROM THE TESTING PLANT (CAR SAMPLES).

As the coal was unloaded directly into a crusher the sample was taken from the buckets of the conveyor which elevated the crushed coal. This crusher reduced the coal to about 1¼-inch size. A small shovelful of the coal was taken at intervals of several minutes from the bucket of the conveyor as the car was unloaded. This sample, weighing from 200 to 600 pounds, was then either sent through the ½-inch crusher and again sampled at the conveyor, or, as was more usually the case, broken down by hand. Samples from the boiler and gas-producer plants were taken by putting aside several shovelfuls every time a charge was weighed, just previous to use under the boilers or in the producer. In sampling the "refuse" from the boilers, special care was taken to break up all lumps of clinker.

In the coking plant the oven charge was from 4 to 7 tons, and the sample of coal for analysis was usually obtained from the truck just before the load was emptied into the oven. Small shovelfuls were taken from various parts of the load and mixed. The samples of coke sent to the laboratory consisted of 2 to 5 representative segments, including butts, and weighed from 20 to 30 pounds. Other samples were taken in the same general way, and in all cases an effort was made to procure samples that should represent the average composition of the material tested.

The scheme for taking car samples, as originally outlined, contemplated the complete unloading of the car into bins before the coal was distributed to the different tests. The sample taken under these circumstances would represent the average of the entire carload. Owing to the limited storage capacity and the conditions of the work it was not possible to carry out this plan, and the car was frequently unloaded, portions at a time, as the coal was needed in the tests. The car sample obtained under these conditions did not always represent the entire car, and in a few cases where the car sample was analyzed before the entire car was unloaded and it was possible to take an additional sample of the remainder, such sample was taken and analyzed for moisture, ash, and sulphur. In the tables these results are given in connection with the regular car sample. A record was kept of the amount of coal sampled in obtaining the car sample, and this is given in the table of results.

REDUCTION OF THE SAMPLES.

The large sample, obtained as described, was emptied upon a platform or floor and thoroughly mixed. The large lumps were broken to egg size or smaller, and the sample was then divided by "quartering." Two diagonally opposite quarters were rejected, and the remainder was mixed and gone over again with a hammer to break down still further the larger pieces and again quartered. This process was repeated until a sample averaging about 50 pounds was obtained, which was taken to the laboratory. The laboratory sample contained no lumps over about 1 inch in diameter. During the reduction an effort was made to break down any visible lumps of slate or pyrites to one-half inch or smaller and thus insure their better distribution. This work was always done promptly, and the final sample was put into a closely covered can to prevent moisture changes. The cans used for holding and carrying the samples to the laboratory were ordinary 6-gallon garbage pails and were provided with a closely fitting and overlapping cover. This form of can was required not only to prevent moisture changes, but also to prevent water from accidentally getting into the sample, either in the washery building or when the sample was sent to the laboratory in rainy weather. This method of sampling was agreed to by those in charge of the different departments, and each department agreed to assume the full responsibility for the proper taking, preliminary preparation, care, and identification of the samples it sent to the laboratory. The chemical department assumed responsibility only for the sample as it was received in the can. The various departments could, of course, modify the process as the exigencies of the work might necessitate. In practically all cases, however, the car samples were taken under the supervision of the chemical department, and the man doing the work reported regularly to the laboratory for instructions.

The work of marking and identifying the car samples was done by those in charge of the unloading, the chemical department not being responsible for it.

HANDLING OF THE SAMPLES IN THE LABORATORY.

MINE SAMPLES.

To each sample as it was received was given a serial number, and the label was copied in duplicate in the laboratory record books. As soon as opened, the sample, when necessary, was run through the jaw crusher set fine, and any lumps were thus broken up. The sample was then weighed and spread upon shallow galvanized-iron trays, 22 by 26 inches in size, to air dry. The time at which the weighing was done, as well as the temperature and humidity of the air, was recorded. Air drying was continued for from twenty-four to ninety-six hours, or until the loss between two successive weighings, made twelve to twenty-four hours apart, became small, usually less than 1 per cent. Temperature and humidity readings were taken at the time of each weighing. The air-dried sample was then well mixed and divided, by quartering, into two parts. One part was put into a glass jar, labeled, sealed, and set aside as a reserve sample. The other portion was run through the crushing rolls; the product, which had now a fineness of less than one-twentieth of an inch, was thoroughly mixed and divided by quartering until it was reduced to about 2 ounces. This was then rubbed on the bucking plate till it passed a 60-mesh sieve, and then it was put into a bottle, which was securely closed with a rubber stopper. This constituted the analytical sample. The earlier samples, if apparently dry, were sampled down direct without air drying. The moisture content of an apparently dry sample was in some cases considerable, and it was soon found to be more satisfactory to air dry all samples previous to the final sampling, and all later samples were so treated.

TESTING-PLANT SAMPLES.

These, as stated, were brought to the laboratory in closed metal pails. Each sample was accompanied by a descriptive card, made out in duplicate and signed by the man in charge of the department from which the sample came. To each sample was at once given a serial number, which was entered upon each portion of the descriptive card; the return portion of this card was signed and sent back to the department sending the sample, and the other half of the card was placed on file as a part of the laboratory records. The sample, amounting to 50 pounds or more, was put through the jaw crusher, then divided by quartering until it was reduced to an amount varying from 2 to 10 pounds, which was then air dried, and the sampling was continued in the same way as with the mine samples. When the sample from the testing plant contained no visible lumps of slate and pyrites and was free from lumps of coal of any considerable size, it was mixed and divided, and only a half, or in especially clean samples only a quarter, was run through the jaw crusher. In many cases samples from the washery were too wet to run through the crusher and were quartered down at once to 10 or 15 pounds and then air dried and sampled.

Samples of ash from the boiler tests always came to the laboratory dry and were sampled direct without further drying. Coke samples were broken to egg size, well mixed, and quartered. One portion was reserved for the tests for apparent specific gravity; another quarter was then put through the crusher and sampled as usual. The crushed coke samples were air dried only in case they were wet.

ANALYTICAL WORK.

DETERMINATIONS AND RECORDS.

To reduce the danger of loss from fire or other accident, all records in the laboratory were made in duplicate; one set was kept in the laboratory and the other filed at the general office of the testing plant in the Mines and Metallurgy building.

The weighing in the analytical work was done on a No. 2 Troemner balance; the weights used were tested as to their adjustment every two or three weeks. To guard against errors in counting and recording weights, not only were the weights used recounted and also the fractional weights remaining unused in the box, but the amount of the latter, plus the unused portion of the beam scale, was entered in the record above and to the right of the weight, found as follows:

$$\text{Weight} = 16.5\,7\,8\,6^{\;4\;2\;1\;4}$$

As the sum of the numbers must be 1 gram, it was easy, on checking over the work, to discover any error of counting or recording, and where such was found, the result was rejected and the work repeated. The probability of two errors "balancing" was small and the system was found very satisfactory.

The determinations when practicable were run in sets of six. To avoid crossing of samples in "weighing out," the crucibles were numbered in series and the samples and crucibles set in numerical order. After the set was weighed out the record was checked by a second person, who compared it with the arrangement of the samples and crucibles. The record was then marked "checked" and signed with the initials of the observer.

All the beakers, flasks, and crucibles used in the routine work were serially numbered, and confusion of numbers was guarded against by systematically comparing these numbers when a transfer was made from one vessel to another.

The calorific value was determined in duplicate upon each car sample. A determination was also made upon one of the two mine samples corresponding to each carload, upon a sample from each lot of briquettes used in steam tests, and upon each sample of coal from the producer-gas tests. The calorific value of the steam-test sample was usually derived from the values obtained on the car sample by correcting for differences in moisture, ash, and sulphur as shown by the proximate analysis.

An ultimate analysis was made in duplicate on each car sample and on a sample from each lot of briquettes used in the steam tests.

The proximate analysis and the determination of sulphur was made upon practically every sample that came into the laboratory. The work was done in duplicate on all car samples, and frequently upon the others.

Nitrogen was determined in duplicate upon each car sample. Single determinations were made upon many mine samples, and a determination was made upon a sample from each lot of briquettes used in the steam tests.

Determinations of the real and apparent specific gravity were made upon all coke samples.

Phosphorus was determined in all coke samples.

Laboratory coking tests were made upon many of the mine samples.

Sulphur in the ash was determined upon a number of samples of coke used in the foundry tests.

METHODS EMPLOYED.

DETERMINATION OF CALORIFIC VALUE.

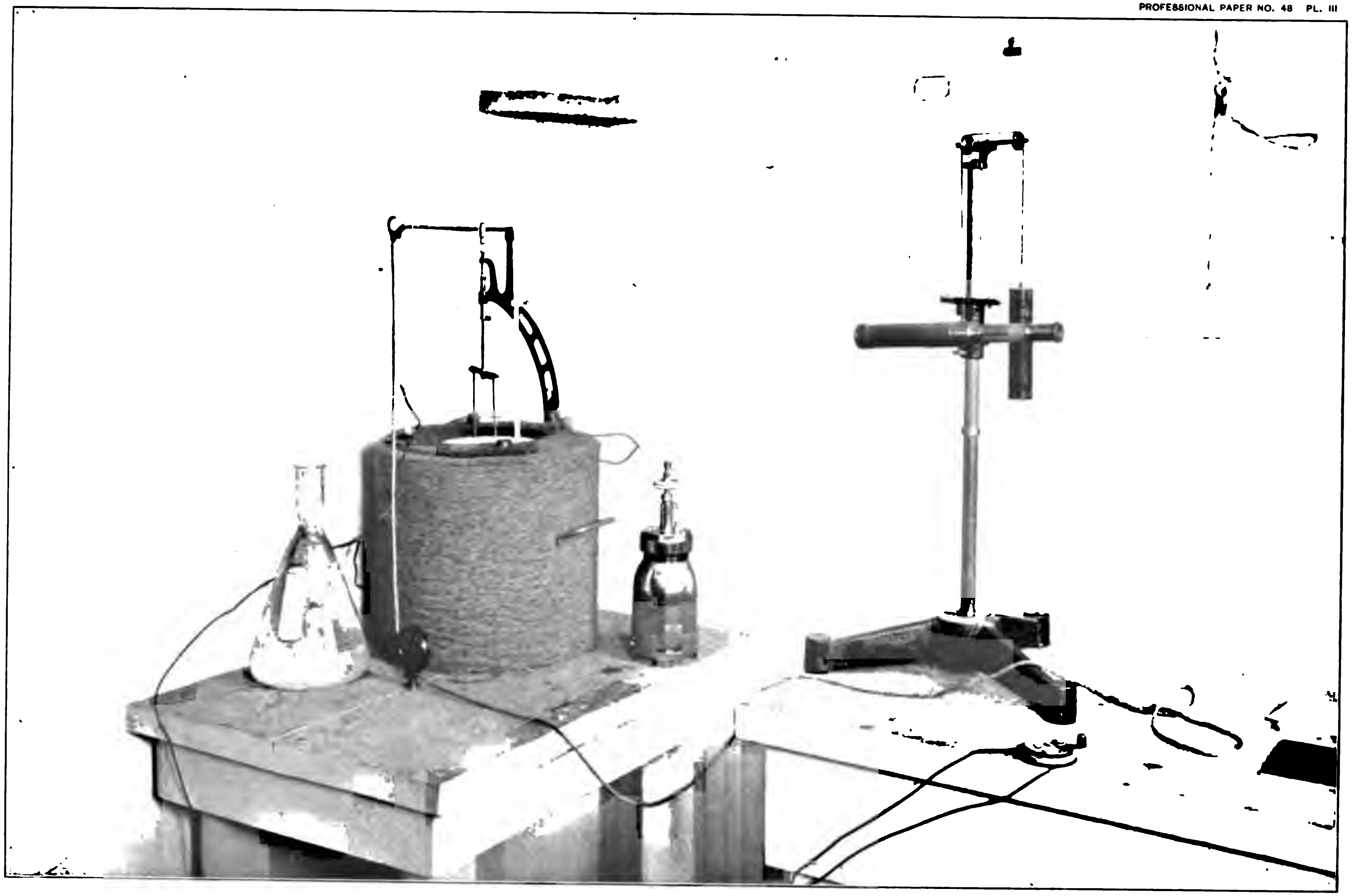
This was made in the Mahler bomb calorimeter, which was installed in a special room set apart for that work. The oxygen used was furnished by A. Hawkridge, Hoboken, N. J. It was tested for hydrocarbon impurities by passing 3 liters through a combustion train over hot copper oxide. No perceptible increase was noted in the weights of the absorption apparatus for water or carbon dioxide. This indicated freedom from more than traces of such impurities. The thermometers used were calibrated by Professor Boyd, of the Ohio State University, and were found to be correct in graduation to within errors of less than 0.002° C.

The water equivalent of the apparatus was obtained by three methods. Closely agreeing determinations upon resublimed naphthalene gave an average of 556 calories for the water equivalent of the calorimeter, 9,692 being used as the calorific value of naphthalene. Determinations of the water equivalent were also made by adding definite amounts of warm water to definite amounts of water in the calorimeter. The average of twelve trials gave 559 calories as the water equivalent of the calorimeter. Calculation of the water equivalent from the weights and specific heats of the different parts of the calorimeter gave 573 calories. This value can be only approximately correct, as the weight of the enamel lining of the bomb could only be estimated. The water equivalent obtained by calculation from the weight of the parts is too high, as a considerable portion of the apparatus is not immersed in water. As a result of these figures, 560 calories were taken as the water equivalent in the earlier determinations. Later, with different cylinders of oxygen, the calorific values obtained for naphthalene, this value being used for the water equivalent, were a little too high. On this account 550 calories were taken as the value of the water equivalent when this oxygen was used. A pressure of 18 atmospheres of oxygen was used in the bomb, except in some duplicate determinations, in which 25 atmospheres were used. As these gave practically identical results, the lower pressure was deemed sufficient. Two thousand four hundred and twenty-five grams of water were used in the bucket of the calorimeter. The number of calories corresponding to one degree increase in temperature was 2,425+550=2,975.

The water was measured, not weighed. A large measuring flask was calibrated for delivery by weighing at a definite temperature. A table was then prepared, giving, for different temperatures, the number of cubic centimeters of water to be added to that measured in the flask in order to make 2,425 grams. In all cases the time of draining the flask was the same. As an error of 1 cc. in the measurement would involve only a difference of 2 or 3 calories the method was deemed satisfactory.

The iron-wire fuse used to start the combustion was ignited by a current from six cells of a dry battery connected in series.

The thermometer in the calorimeter was read through the telescope of a simple cathetometer placed about 5 feet from the instrument. This apparatus was designed and built for the laboratory by Prof. H. C. Lord, of the Ohio State University. The sliding carriage carrying the telescope was provided with a counterbalancing weight, and could be moved up and down the vertical rod smoothly and easily in following the mercury in the thermometer.



CALORIMETER AND READING TELESCOPE.

Samples for calorimeter determinations were thoroughly mixed on paper and about 2 grams were taken from various parts. This amount was put into an iron mold and pressed into a small briquette by means of a plunger and a screw press. The amount of pressure used depended upon the nature of the coal. Coal of the Pocahontas type required much less pressure than coal high in volatile matter. The pressure used was just sufficient to make a briquette firm enough to hold together. More pressure than this was avoided, as too great hardness in a briquette frequently resulted in incomplete combustion of the sample.

The briquette made in this manner was then broken into a number of pieces and approximately 1 gram weighed out in the platinum combustion tray of the calorimeter, the exact weight being recorded. Pressing the coal into briquettes prevents loss from the fine sample blowing out of the tray. The breaking up of the briquette into smaller pieces aids in securing complete combustion. Fewer failures from unburned coal resulted from working in this way than when the briquette was weighed entire.

To secure satisfactory results with reference to temperature changes during a determination, it was necessary to vary the temperature of the water used in the inner bucket of the calorimeter to correspond with variations of the temperature of the room and of the temperature of the water in the outer jacket of the calorimeter. An effort was always made to have the temperature of the water in the outer jacket within a few degrees of the room temperature. The water to be used in the inner bucket of the calorimeter was then cooled till the temperature was about 2° below that of the water in the outer jacket. Care was taken that this temperature was not too near the dew-point, and in damp weather the water in the outer jacket had to be kept on this account at a temperature several degrees above that of the room. By working under these temperature conditions, the greatest rate of change occurred before combustion, and the rate of change in temperature after the combustion period was small. The larger the rate of change, the larger the possible error. The effects of the large rate before the combustion period is, after the first minute of the combustion period, very small. The small rate after the combustion period is carried back and operates through an interval of several minutes; hence the desirability of having the larger rate before the combustion, rather than after it, is evident.

The calculations used and the corrections applied are most easily explained by reference to a typical determination, as given below:

United States Geological Survey coal-testing laboratory, World's Fair, St. Louis, Mo.

Sample No. *1297.* Date, *11-7-04.*

	Jacket water = 20°	**Tray**	coal = *$9.5^4 6^3 0^9 5^5$*	
Time.	*Wet and dry bulbs = 16–23°*	**Tray**	= *$8.5^4 5^4 6^4 0^0$*	
	Readings:	**Coal**	= *1.0045 gms.*	

1-21				
22	*18.452*			
23	*18.460*			
24	*18.466*	*Rate of gain = .0065*		*21.080*
25	*18.472*			*18.478*
26	*18.478*	*+.0065*	*+.0026*	*2.602*
26½	*19.1*	*+.0040*	*+.0006*	*.0081*
27	*20.5*	*.0017*		*2.6101*
			−.0029	
28	*21.080*	*−.0042*		*W. E. = 2975 for 1°*
			−.0042	
29	*21.088*	*−.0042*		*5950*
30	*21.080*	*−.0042*	*−.0042*	*1785*
31	*21.076*	*Sum =*	*−.0081*	*29.8*
32	*21.072*			*0.0*
33	*21.066*	*Rate of loss = .0042*		*0.3*
34	*21.062*			*7765.1*
35	*21.058*			*50.1*
36	*21.055*			*7715.0*
		Correction for excess weight of sample taken =		*34.2*
				7680.8
			Calorific value =	*7681*

Wire fuse = *12.1* mg.
Wire fuse, unburned = *3.5* mg.
Wire fuse, burned = *8.6* mg. (1 mg. = 1.7 cal.) = *14.6* cal.
Niter = *8.5* (1 cc. = *2.65* cal.) = *22.5* cal.
Sulphur in coal = *1.00%* (.01 gm. = 13 cal.) = *13.0* cal.
Total correction = *50.1* cal.

Thermometer used, No. *3598.* Position, *5.5 cm.*
Room temp. beginning = *23°*; end = *23°+*.
Atm. oxy. used = *17.5.* Valve, *tight.*
Water added at 18° = 9.7 cc.
(Signed) *E. E. S.*
Checked by J. W. G.

As is shown, the records include the following points: Room temperature at the beginning and end of the determination; humidity of the atmosphere (wet and dry bulb readings); temperature of the water in the outer jacket of the calorimeter; pressure in atmospheres of the oxygen in the bomb; condition of the valve of the bomb, whether tight, or if not, the extent of the leak; position of the thermometer in the calorimeter during a determination—that is, the distance of the lower end of the bulb of the thermometer above the bottom of the calorimeter bucket, 4 to 5 cm. being taken as the standard distance. In making a determination no rigid rule was followed with reference to the combustion period. It is our opinion that better and more concordant results may be obtained by allowing for the variations incident to the individual determinations. In beginning a determination minute readings were taken until a regular rate of change had been established. This usually required only five or six readings, but occasionally seven or eight. When the initial rate was established, the combustion was begun at the time of the next minute reading by throwing the battery of dry cells into circuit with the calorimeter. During the first minute after ignition half-minute readings were taken, after which minute readings were taken until a final rate of change had been established. This usually required about ten readings, but occasionally as many as fifteen were taken. The temperature taken for the beginning of the combustion was the reading taken at the time of the burning of the wire fuse. For the end of the combustion period the first temperature reading was taken, which fell well within the established final rate. The corrections applied to the combustion period were obtained by taking into account that the changes in the rate of gain or loss in temperature are proportional to the changes in temperature. From this proportion the rate of gain or loss at the beginning and end of each interval of time was found. In the typical determination given, these values are placed opposite each temperature reading which falls within the combustion period. The temperature readings at the beginning and end of the combustion period are indicated by check marks. The temperature correction for each interval during the combustion period is obtained by adding the rates at the beginning and end of the interval and dividing the algebraic sum by 2 for the minute intervals and by 4 for the half-minute intervals. The sum of these corrections, added to the difference between the readings at the beginning and end of the combustion period, is the true temperature change due to the combustion. This multiplied by the water equivalent of the calorimeter system gives the total calories of heat produced by the combustion. Other corrections necessary are those for the combustion of the wire fuse, for the formation of nitric acid, and for the combustion of the sulphur to sulphuric acid instead of sulphur dioxide.

A definite length of iron wire corresponding to a weight of 12.1 milligrams was used as the fuse to start the combustion of the sample. The unburned portion was measured and the corresponding weight subtracted from the weight of fuse used. This remainder multiplied by 1.7 gives the correction in calories.

In order to make the correction for aqueous nitric acid and sulphuric acid, the washings from the bomb were titrated with the standard ammonia used in the determination of nitrogen. One cubic centimeter was equivalent to 0.0025 gram of nitrogen as nitric acid, and as the heat of formation of aqueous nitric acid is 1,058 calories per gram of nitrogen, each cubic centimeter stood for a correction of 2.65 calories.

As part of the acidity was due to sulphuric acid formed by the combustion of sulphur, a further correction was necessary. The sulphur in the coal is considered as burning to sulphur dioxide in ordinary combustion; but in the bomb it burns to aqueous sulphuric acid, the heat of formation of which is 4,450 calories, while that of sulphur dioxide is only 2,250 per gram of sulphur. For each gram of sulphur present the heat developed in the bomb is in excess by 2,230 calories, which is 22.3 for each per cent of sulphur present in the coal.

One cubic centimeter of the ammonia is equivalent to 0.00286 gram of sulphur as sulphuric acid, or to $0.286 \times 22.3 = 6.38$ calories. It is evident that after multiplying the number of cubic centimeters used in the titration by the heat factor for nitric acid (2.65) it is necessary to make a further correction of $6.38 - 2.65 = 3.73$ for each cubic centimeter used in titrating sulphuric instead of nitric acid. This is a correction of $\frac{3.73}{0.286} = 13$ units for each 0.01 gram of sulphur in the coal. The correction was accordingly made by multiplying the ammonia by 2.65 and adding 13 units for each 0.01 gram of sulphur in the coal.

ULTIMATE ANALYSIS.

APPARATUS AND OPERATIONS.

Ultimate analyses were made in a 25-burner Bunsen combustion furnace. The purifying train through which the air and oxygen were passed before they entered the combustion tube was arranged in duplicate, one part for air, the other for oxygen. The purifying reagents, arranged in the order named, were sulphuric acid, potassium hydroxide, soda lime, and granular calcium chloride. The combustion tubes used were about 1 meter long and about 18 mm. internal diameter. The tube extended beyond each end of the furnace for a distance of about 10 cm., the ends of the tube being protected from the heat of the furnace by closely fitting circular shields of asbestos. The rear end of the tube (the end next to the purifying train) was closed with a rubber stopper. This end of the tube being thus kept cool, as well as by the passage of cool air and oxygen, there was no danger that volatile products would be given off by the rubber. The other end of the tube was closed by a well-rolled cork of specially selected quality, the danger from overheating at this end of the tube being too great to permit of the use of the more convenient rubber stopper. The rear end of the tube for a distance of 25 cm. inside the furnace was left empty; the next 35 cm. were filled with a loose layer of wire copper oxide, with a plug of acid-washed and ignited asbestos at either end to hold the oxide in place. The copper oxide was followed by a layer about 10 cm. in length of coarse fused lead chromate, to stop sulphur products, this being held in place by a final plug of asbestos.

The absorption train was as follows: The water was absorbed in a 6-inch Marchand U tube, filled with granular calcium chloride; the carbon dioxide was absorbed by potassium hydroxide in an ordinary Liebig bulb, to which was attached a 3-inch U tube, containing soda-lime and calcium chloride, the bulb and U tube being weighed up together. This was followed by a final guard tube filled with calcium chloride and soda lime. The gases formed during combustion were drawn through the train by suction, a Marriott bottle being used to secure a constant suction head. The oxygen used was kept over water and was supplied under small pressure. The supply of oxygen and the aspiration during a combustion were so regulated as to keep the difference in pressure between the inside and outside of the tube very small, the pressure inward being slightly greater. This reduced the danger of leaks to a minimum, and, if by chance any slight leakage did occur, it was inward rather than outward and the effect upon the determination was small.

Before weighing out the portion for determination the sample was well mixed on paper and about 2 grams, from various parts, placed in an agate mortar. This was rubbed a few times with the pestle for the purpose of more complete mixing. Two-tenths of a gram was then rapidly weighed into a weighed platinum boat, and immediately transferred to the combustion tube. Before beginning the determination the train was tested to prove that the absorption apparatus did not change in weight on aspirating air. The mixing and weighing out of the sample was done as quickly as possible in order to guard against moisture changes, and required from two and a half to three minutes from the time of beginning till the sample was in the combustion tube. Samples high in moisture lost, by experiment, as much as 1 per cent of moisture, when spread out in a thin layer and exposed to the air of the laboratory for ten minutes. The method used is therefore not entirely satisfactory, but in our opinion no better one has as yet been worked out. This liability to moisture losses is of especial importance with reference to the ultimate analysis and the determination of the calorific value, the effects upon the determination of ash, sulphur, and nitrogen, being relatively much less important.

That part of the process relating to the actual combustion of the sample is as follows: The platinum boat containing the sample was inserted into the rear end of the tube and pushed nearly or quite up to the asbestos plug holding the copper oxide in place. The part of the tube containing the boat was kept cool till a considerable portion of the copper oxide (20 to 25 cm.) was at a bright-red heat and the lead chromate heated to a barely visible red. The burners back of and under the boat were then turned on very gradually and the volatile products slowly driven off, a slow rate of aspiration (1 or 2 bubbles a second) being kept up and care being taken not to drive off the products so rapidly as to cause any back pressure. The driving off of the volatile products requires the closest attention and the raising of the heat must be very gradual, otherwise results are apt to run low, probably from failure to secure complete combustion. The volatile products having been driven off, oxygen was turned on and allowed to pass over the sample heated to dull redness. The ignition is characterized by considerable glowing and the oxygen must be passed rather slowly or else passed over mixed with a considerable quantity of air. Too rapid combustion may cause fusion of the ash and the retention of unburned coal. The ash after a determination was always examined for evidences of fusion or the presence of unburned carbon. Oxygen was passed through the train for several minutes after the last evidences of combustion had disappeared, or till it began to bubble freely through the potash bulbs. About 1,200 cc. of air were then aspirated through the train before weighing up.

After the completion of the combustion, the burners under the rear end of the furnace were gradually turned down and out. Those under the front end of the copper oxide were, however, left partially turned on, and this portion of the copper oxide was thus kept hot. This diminished the time required for preliminary heating during the next combustion.

NITROGEN.

Nitrogen was determined by the regular Kjeldahl method. One gram of the sample was weighed out as usual and digested with 30 cc. of concentrated sulphuric acid and about 0.65 gram of metallic mercury. The digestion was continued for about three-quarters of an hour after the oxidation was apparently complete, the total time being about three hours.

The mercury was measured into the flask through a glass stopcock partially filled with plaster of Paris, so that every time the cock was turned around it delivered a drop of mercury. This, when once correctly gauged, was found to give practically constant amounts and was very satisfactory.

As sulphur determinations were being made in the laboratory, every effort was made to prevent the fumes from the digestion flasks getting into the air. The work was done in a special hood, and the necks of the flasks were inserted into a long cylinder of lead through the openings in the side. The lead cylinder was about 4 inches in diameter and 20 inches long, and similar to the apparatus used in the Department of Agriculture. There was a drainpipe in the lower part for the escape of the condensed acid. The cylinder was connected with a large water aspirator of special design, which sucked out the fumes and carried them down into a drain and out of the building. The aspirator was made of lead and was arranged to aspirate a large volume of air at a small "head" and with but little water. It consisted of a "step-down" arrangement by which a jet of water first drew air into a small tube as in the ordinary aspirator, and this acted as the jet in a second larger tube in which the mixed stream of air and water moved a large volume of air. The suction was sufficient to draw the air into the lead cylinder around the necks of the flask rapidly. The acid fumes were absorbed by the water, and practically none escaped even into the hood. The aspirator was connected to the cylinder by a three-fourths inch lead pipe.

The ammonia from the distillation was absorbed in 10 cc. of standard sulphuric acid of which 1 cc. was equivalent to 0.005 gram of nitrogen. The residual acid was titrated with standard ammonia of just half the strength of the acid (1 cc. = 0.0025 N).

The acid was measured from an overflow pipette. The burette used for the ammonia was graduated from the top down in cubic centimeters and from the bottom up in percentages of nitrogen. Both readings were recorded and when the results were checked up the percentage calculated from the cubic centimeter reading had to agree with the percentage read directly. This gave a complete check on the burette reading and the recording. As 20 cc. of the ammonia is equivalent to 10 cc. of the acid, the percentage readings started with zero at the 20 cc. mark and were 5 per cent at the top or zero of the cc. scale. Obviously 20 minus the reading in cubic centimeters and divided by 4 must give the percentage.

SULPHUR.

Methods of determination.—The Eschka method was used on all regular samples. Many determinations of sulphur were made also on the washings from the Mahler calorimeter. The comparison of the results by the two methods is shown in the tabulated results on page 277.

The routine of work by the Eschka method was as follows:

The determinations were made in sets of six, and as a check upon reagents and method of work a blank determination was run with every third set. The burning was done in 30 cc. platinum crucibles. In nearly all cases the amount of sample used was 1 gram; in a few of the determinations upon coke the duplicate determinations were made upon one-half gram of sample.

The sample in every case was well mixed on paper before weighing. The weighed sample was well mixed in the crucible with about 1½ grams of the "Eschka mixture," and about one-half gram was then spread on top as a cover. The burning was done over alcohol lamps. At the beginning the flame was kept very low until the volatile combustible was burned out. This required from fifteen to thirty minutes. The heat was then increased and the mixture was stirred occasionally with a platinum wire. The heating was continued until all traces of unburned carbon had disappeared. In many of the determinations the final burning was done in the gasoline muffle furnace. Practically all of the coke samples were finished in this way, as the complete burning of cokes over an alcohol lamp is very difficult.

The mixture in the crucible was then transferred to a numbered beaker and digested with 75 cc. of water for thirty minutes. The solution was then filtered, the residue washed twice with hot water by decantation and then washed on the filter, small portions of water being used for each washing till the filtrate amounted to 200 cc. Bromine water in excess was then added and the solution was made slightly acid with hydrochloric acid. The amounts of these reagents usually added were 4 cc. of water saturated with bromine and 3 cc. of concentrated hydrochloric acid.

The solution was heated to boiling and the sulphur was precipitated with 20 cc. of a hot 5 per cent solution of barium chloride, slowly added from a pipette during constant stirring. The precipitate was allowed to stand at a temperature a little below boiling for two hours or longer before filtering. The filtrate from the barium sulphate was tested for acidity by means of litmus paper, and for excess of barium chloride by adding a few drops of dilute sulphuric acid to a few cubic centimeters of the filtrate in a test tube. The preliminary washing of the precipitate was done with hot water containing 1 cc. of hydrochloric acid per liter. The final washings were made with hot water alone and the washing was continued until the washings no longer reacted for chlorine when tested with silver nitrate.

The precipitate was ignited in a porcelain crucible. The filter and precipitate were placed in the crucible, precipitate uppermost, and the filter was folded only enough to prevent loss by spattering. A low heat was used until the paper was entirely "smoked off." The heat was then raised sufficiently to bring the precipitate to dull redness, and the heating continued for a few moments, or until the carbon was burned out. The crucible and precipitate were then cooled and weighed.

Sulphur in coke ash.—This determination was made upon only a few samples, the determination not being included in the original outline of the laboratory work. Two grams of sample were burned to ash; the ash was treated with 5 cc. of concentrated nitric acid and about one-half gram of potassium chlorate and then evaporated nearly to dryness. Fifteen cubic centimeters of concentrated hydrochloric acid were added and the solution was digested for fifteen minutes. The solution was then evaporated to hard dryness. The residue was moistened with 2 cc. of strong hydrochloric acid, 75 cc. of water were added and the whole was digested for fifteen minutes. The solution was then filtered, the residue washed with hot water, and the sulphur determined in the filtrate by precipitation as barium sulphate.

PHOSPHORUS.

Phosphorus was determined only in the coke. For a determination 6.52 grams of coke were taken and burned to ash over a Bunsen burner or in the muffle furnace. The ash was fused with sodium carbonate, plus 0.2 gram of sodium nitrate; more nitrate than this attacked the platinum crucible. The fused mass was then dissolved in water, acidified, and the solution was evaporated to dryness. After taking up in hydrochloric acid the phosphorus was determined by weighing the yellow precipitate of phospho-dodecamolybdate of ammonium, obtained in the usual way. The determinations were run in sets of four to six, and as a check upon the purity of the yellow precipitate the phosphorus in the combined precipitates from each set was determined by the magnesia method. In no case was much impurity found. Tabulated results showing the agreement between the two methods are given on page 279.

PROXIMATE ANALYSIS.

MOISTURE AND ASH.

The sample was mixed on paper, as described before, and 1 gram was weighed into a porcelain crucible. The crucible containing the sample was put in a double-walled air bath and dried for one hour, the bath being kept as near 105° C. as the variable nature of the gas pressure permitted. The usual range was from 103° to 108°.

Determinations were made in which the oven temperature ran up to 120° for a short time, but these when duplicated gave practically the same results as at 105°. It was therefore assumed that the minor variations made no appreciable difference.

The samples were run in sets of six. At the end of the time the crucibles were covered and placed one at a time in desiccators containing calcium chloride and allowed to cool.

The crucible was weighed as rapidly as possible, the weight being taken to the nearest half milligram, and also the crucible weighed without the cover.

The drying oven was about 10 by 10 by 12 inches inside measurement, and was ventilated by a small opening in the top.

The ash was determined in the same portion. The crucible was heated until all the combustible matter was removed, and the crucible and remaining ash were weighed.

The burning was sometimes done over a Bunsen burner, but in most cases in a small gasoline muffle furnace. This furnace, with tank, burner, pump, etc., was furnished by F. W. Braun & Co., of Los Angeles, Cal. It was found very satisfactory, requiring little attention.

The temperature was kept very low at the beginning of the burning and until all the volatile matter was expelled. It was then raised to low redness and so kept till the carbon was apparently removed, the burning being hastened by stirring the contents occasionally with a platinum wire. The crucibles were then weighed and returned to the furnace. The ash was always burned until the weight became constant or until the change after twenty or thirty minutes' burning was less than about half a milligram. In using the muffle care was always taken not to let it become so hot as to cause any fusion of the ash, as a temperature sufficient for fusion of many ashes could be obtained without difficulty.

VOLATILE COMBUSTIBLE MATTER.

The method used was that recommended by the committee on coals of the American Chemical Society. One gram of the sample weighed as before was heated in a covered platinum crucible for seven minutes over the full flame of a Bunsen burner. The crucibles had a capacity of 30 cc. and were supplied with well-fitting lids. The crucibles were supported on platinum triangles, and the distance from the bottom of the crucible to the top of the Bunsen burner was about 7 cm. The free-burning Bunsen burner gave a flame 16 to 20 cm. high. To prevent air currents from interfering with the determination, a cylindrical chimney of asbestos about 15 cm. long by 7 cm. in diameter was used to inclose the burner flame, the platinum triangle upon which the crucible rested being located 3 cm. below the top of the chimney. This arrangement gave a uniform heat, and the temperature attained was such that the lid of the crucible was readily heated to a visible red.

SPECIFIC GRAVITY.

Specific gravity of coke.—Determinations were made of both the specific gravity of the coke substance and the apparent specific gravity of the lump coke. The determination of the apparent specific gravity was made by measuring the volume of water, in cubic centimeters, displaced by a given number of grams of coke. The apparatus used consisted of a 500 cc. glass jar closed with a screw cap and rubber gasket. In the middle of the screw cap an opening 0.6 cm. in diameter was made and the cap so sprung as to bring this opening at the highest point when the cap was in place on the jar and the jar set in a vertical position. A scratch upon the side of the jar and cap served as a guide to enable the cap to be screwed on always to the same position. In making a determination the jar was filled with water to a level across the opening in the cap. By means of a 50 cc. pipette 150 cc. of water were then drawn out. The cap was then taken off, two or three pieces of coke previously dried and weighed were dropped into the jar, and the cap was again screwed on. Water was then added from a burette till the opening in the cap was filled just as at first. The number of cubic centimeters of water added from the burette subtracted from the 150 cc. taken out represented the volume of water displaced by the coke; this result divided by the weight of the coke in grams gave the apparent specific gravity. Care was taken during the operation to displace by gentle shaking any large air bubbles adhering to the surface of the coke. Three determinations were made upon each coke tested, and the average of the three results was taken. The combined weight of the several pieces used for each test was usually about 100 grams. Where the results obtained were very irregular, five or six determinations were made and the results averaged.

Specific gravity of the coke substance.—The method used is in brief as follows: 3.5 grams of the previously dried and finely pulverized sample were placed in a 50 cc. specific gravity flask. The flask was filled about two-fifths full of water, attached to an aspirator, and gently boiled on a water bath under a partial vacuum for two and one-half to three hours. The flask was then detached, cooled, filled with water, and weighed. The temperature of the water in the flask was taken as soon as the flask was weighed. For each bottle used a table was constructed, showing its weight in grams when filled with water at different temperatures. From the weights so obtained the specific gravity of the coke powder was calculated in the usual way. For this work grams of water were considered equal to cubic centimeters.

DISCUSSION OF METHODS OF ANALYSIS.

Such experiments as were made in the time at our disposal to test the general accuracy of the results obtained by the foregoing methods are described in detail on page 275 et seq.

It will appear from these details that so far as the analytical processes themselves are concerned the results may be considered as within the errors liable to arise from variations in the sample. This general conclusion is also supported by the comparatively close agreement of the numerous duplicate determinations that were made in the course of the work. The most unsatisfactory part of the analytical scheme is that involving the determination of moisture. The problem presented in this determination is twofold. It involves, first, the determination of the moisture in the actual sample analyzed in the laboratory, and, second, the ascertainment of the percentage of moisture in the fuel in the condition in which it is used for the various tests—such as the boiler test, gas test, etc.

The method of air drying was expected to bring these two results together, so that the final ground sample could be prepared from the air-dried sample without important change in moisture. It is obvious from the results shown in the experimental work on moisture that this was only partially successful, though it is believed that the tabulated figures for the composition of the fuel will represent the truth much more exactly than if the coal had been sampled without air drying.

A considerable source of error in the analytical work is undoubtedly the extreme liability of the laboratory sample in the pulverized condition to change in moisture content during the weighing out of the portions used for the different determinations. Direct experiments have shown that the average time of exposure of the sample during the operation of weighing out was about three minutes and that this would in some cases be sufficient for marked losses in moisture.

In all cases the sample was mixed on paper before weighing; this was deemed necessary in order to secure a representative portion for the analysis, particularly in the case of coals high in ash and sulphur, in which there is great tendency for the material to separate in the sample bottle. Subsequent experiments have shown that this mixing on paper is not necessary for the portion used in the determination of moisture, but as it was very essential that the determination of moisture should correspond with the other analytical determinations, it was considered best to treat the sample in the same way in all cases, so that any loss of moisture during the weighing out would affect equally portions used for the determination of the calorimetric value, for the ultimate analysis, and for the determination of moisture.

The effect of this procedure is to make all the analytical results, including the moisture determination, represent the coal in a uniform condition and to throw back upon the condition of the sample as received all errors due to loss of moisture during weighing; thus all the results are strictly comparable.

In respect to the determination of moisture itself, it is obvious from the experiments given later on, especially the very interesting results given by Doctor Hillebrand, that the figure obtained for moisture can not be considered as representing all the water in the coal. What is considered as moisture is simply the loss of weight which the coal undergoes by treating it in a certain specified way. If the conditions of drying are changed the moisture figure will also change.

All of the results obtained in the laboratory were made under conditions as nearly uniform as possible, and are therefore strictly comparable with each other. In the great majority of cases duplicate determinations on the same coal gave closely concordant results.

ANALYTICAL RESULTS.

METHODS OF STATEMENT.

In the tables which follow are given all the results reported from the laboratory in connection with the different tests, as well as the analyses made of the car samples and mine samples.

A complete series of results upon any lot of coal tested would comprise analyses of the mine samples, the car sample, the sample from the steam test, the sample from the producer-gas test, the sample from the coke test and the coke from the test, the samples from the washery, and the sample of the briquettes made from the coal. The complete series of tests was applied to only a few coals, for many of the coals were adapted to only a portion of the tests. In some cases more than one sample was sent under one head, as, for instance, where more than one coke test was made on the same coal.

Many of the washery samples were taken from washed coal sent to the ovens or the boilers, and the results of analyses of these have been reprinted under both heads for the sake of uniformity and for convenience in comparing results.

The actual analysis was made, of course, upon the air-dried sample, and these results are given in the tables. The results on the sample as received were calculated by correcting the analysis for the loss of water in air drying, and these corrected results are given with the others. The actual calculation consisted in multiplying the results of the analysis by the fraction that the air-dried coal formed of the original coal and then adding to the figure for moisture so obtained the percentage loss on air drying. In the ultimate analyses the figures so obtained for oxygen and hydrogen were increased by amounts equivalent to the oxygen and hydrogen represented by the loss on air drying when considered as water.

The ultimate analyses and the determinations of the calorific value of the samples from the steam and producer-gas tests are usually derived from the results of the determinations on the car samples of the same coal by taking into account the differences in the ash, moisture, and sulphur in the samples as shown by the proximate analyses.

It was assumed, after deducting the hydrogen and oxygen combined as the moisture in the different portions of the same coal, that the ratio between the carbon, nitrogen, hydrogen, and oxygen remaining was constant. The calculation was as follows: Let the sum of the moisture, ash, and sulphur in the car sample on which the ultimate analysis was made be S and the same for the boiler test sample be S'; let $K=\frac{100-S'}{100-S}$; let the carbon, nitrogen, hydrogen, oxygen, and moisture in the car sample be C, N, H, O, and M, and in the other C', N', H', O', and M', respectively; then

$$C'=KC,\ N'=KN,\ H'=K\ (H-1/9\ M)+1/9\ M'$$
$$O'=K\ (O-8/9\ M)+8/9\ M'$$

On the following two samples from the steam tests the ultimate analysis was made directly. The agreement between the two methods is shown as follows:

Sample 1061...... { Hydrogen determined, 4.77; derived, 4.84.
Carbon determined, 68.94; derived, 68.85.

Sample 1157. .... { Hydrogen determined, 4.82; derived, 4.94.
Carbon determined, 70.00; derived, 70.19.

In deriving the heating value of the steam-test and producer-gas samples from the determinations on the car sample the heating value of sulphur in coal was taken as 2,250 calories and the heating value of other combustible matter in the two samples was assumed to be the same.

The formula is as follows:

Cal. V' = K (Cal. V − 22.5 × per cent sulphur) + 22.5 per cent sulphur in second sample. Cal. V' is the derived calorific value and Cal. V. the calorific value of the car sample. The sulphur in the parenthesis is the sulphur in the car sample.

In the calculation of the calorific value from the ultimate analysis Dulong's formula was used, as follows: 8080 carbon + 34460 (hydrogen − 1/8 oxygen) + 2250 sulphur. Results were changed from calories to British thermal units by multiplying the value in calories by nine-fifths.

The agreement between the derived and the determined calorific values is shown by results upon the producer-gas samples, in most of which both methods were used. These are given in the tabulated list of results.

The agreement between the determined calorific value and the value as calculated from the ultimate analysis by Dulong's formula is shown by the results upon the car samples given in the tabulated list of results. The results upon special samples and the special determinations made in addition to the routine laboratory work are given after the tabulated list of results upon the regular samples.

REGULAR SAMPLES.

In the following tables, showing the results of the work on the regular samples, the analyses are grouped together under the State number designating the kind of coal, and the groups are arranged in alphabetical order of the States.

Chemical analyses of Alabama No. 1 coal.

[Lump and nut coal from mine No. 8. Received from Ivy Coal and Coke Company, Horsecreek, Ala.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 17.[b]	Sample of coal from coke test No. 8, coal unwashed.	Sample of coal from coke test No. 3, coal washed.	Coke sample, washed coal.[c]	Sample from washery test, coarse, screened, unwashed.	Sample of washed coal, screened and coarse.	Sample of briquettes, boiler test No. 21.[d]
Laboratory sample number	1077	1078	1201	1157	1142	1199	1220	1200	1204	1194
Loss of moisture on air drying, per cent			0.80	1.10	1.19	1.90				1.20
Analysis of air-dried sample:										
Proximate—										
Moisture per cent			1.55	1.48	1.57	2.79	0.33	1.56	1.87	1.45
Volatile matter do			32.10	31.34	31.13	31.86	.72			33.40
Fixed carbon do			53.71	53.11	53.26	54.07	82.63			51.58
Ash do			12.64	14.07	14.04	11.28	16.32	14.66	10.36	13.57
			100.00	100.00	100.00	100.00	100.00			100.00
Ultimate—										
Hydrogen do			4.96							4.80
Carbon do			72.16							71.59
Nitrogen do			1.66							1.40
Oxygen do			7.85							7.69
Sulphur do			.73	.79	.77	.91	.69	.70	.90	.95
Ash do			12.64							13.57
			100.00							100.00
Calorific value determined: calories			7,199							7,172
Calorific value determined: B. T. U			12,958							12,909
Calorific value calculated from ultimate analysis: calories			7,218							7,130
Calorific value calculated from ultimate analysis: B. T. U			12,992							12,834
Phosphorus in coke							.047			
Analysis corrected to sample as received:										
Proximate—										
Moisture per cent	1.22	1.35	2.34	2.56	2.65	4.64				2.63
Volatile matter do	31.53	31.67	31.84	31.00	30.79	31.25				33.00
Fixed carbon do	54.44	53.35	53.28	52.52	52.68	53.05				50.96
Ash do	12.81	13.63	12.54	13.92	13.88	11.06				13.41
	100.00	100.00	100.00	100.00	100.00	100.00				100.00
Ultimate—										
Hydrogen do			5.01							4.87
Carbon do			71.58							70.73
Nitrogen do			1.65							1.38
Oxygen do			8.50							8.67
Sulphur do	.71	.71	.72	.78	.76	.89				.94
Ash do			12.54							13.41
			100.00							100.00
Calorific value determined: calories		7,217	7,142	[e]7,003						7,086
Calorific value determined: B. T. U		12,991	12,856	[e]12,605						12,755

[a] Represents 20 tons of coal.

[b] Refuse from boiler test, laboratory No. 1158: Combustible, 26.20 per cent; ash, 73.80 per cent.

[c] Specific gravity of the coke substance, 1.92; apparent specific gravity of coke, 0.95; percentage of porosity, 51.

[d] Refuse from boiler test of briquettes, laboratory No. 1193: Combustible, 18.80 per cent; ash, 81.20 per cent.

[e] Derived from determinations on carload sample.

Chemical analyses of Alabama No. 2 coal.

[Lump, nut, and pea coal from mine No. 5. Received from Galloway Coal Company, Carbon Hill, Ala.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 16.[b]	Sample from gas-producer test No. 2.	Sample of coal from coke test No. 7.
Laboratory sample number	1075	1076	1225	1141	1216	1136
Loss of moisture on air drying ... per cent	....	....	0.80	2.60	0.50	1.50
Analysis of air-dried sample:						
Proximate—						
Moisture ... per cent	....	....	2.58	2.29	3.28	2.30
Volatile matter ... do	....	....	33.15	33.86	33.62	33.10
Fixed carbon ... do	....	....	51.74	49.95	53.55	51.36
Ash ... do	....	....	12.53	13.90	9.55	13.24
			100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen ... do	....	....	4.79	....	....	....
Carbon ... do	....	....	69.24	....	....	....
Nitrogen ... do	....	....	1.55	....	....	....
Oxygen ... do	....	....	10.87	....	....	....
Sulphur ... do	....	....	1.02	1.20	.86	1.45
Ash ... do	....	....	12.53	....	....	....
			100.00	100.00	100.00	100.00
Calorific value determined ... calories	....	....	6,916	....	7,183	....
Calorific value determined ... B. T. U.	....	....	12,449	....	12,929	....
Calorific value calculated from ultimate analysis ... calories	....	....	6,799	....	....	....
Calorific value calculated from ultimate analysis ... B. T. U.	....	....	12,238	....	....	....
Analysis corrected to sample as received:						
Proximate—						
Moisture ... per cent	2.26	2.42	3.36	4.83	3.76	3.77
Volatile matter ... do	35.70	34.88	32.88	32.98	33.45	32.60
Fixed carbon ... do	53.00	51.62	51.33	48.65	53.29	50.59
Ash ... do	9.04	11.13	12.43	13.54	9.50	13.04
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen ... do	....	....	4.84	....	....	....
Carbon ... do	....	....	68.69	....	....	....
Nitrogen ... do	....	....	1.54	....	....	....
Oxygen ... do	....	....	11.49	....	....	....
Sulphur ... do	1.09	1.10	1.01	1.17	.86	1.43
Ash ... do	....	....	12.43	....	....	....
			100.00			
Calorific value determined ... calories	7,296	7,053	6,861	6,639	[c]7,147	....
Calorific value determined ... B. T. U.	13,133	12,695	12,350	11,950	[c]12,865	....

[a] Represents 27 tons of coal.
[b] Refuse from boiler test, laboratory No. 1143: Combustible, 15.10 per cent; ash, 84.90 per cent.
[c] Calorific value derived from the determinations on the carload sample: 7,088 calories; 12,758 B. T. U.

Chemical analyses of Arkansas No. 1 coal.

[Lump and nut coal from mine No. 1. Received from Central Coal and Coke Company, Huntington, Ark.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 9.[b]	Sample of coal from coke test No. 5.	Sample of briquettes, boiler test No. 14.[c]
Laboratory sample number		1045	1046	1104	1105	1107	1135
Loss of moisture on air drying	per cent..			2.10	1.00	1.00	
Analysis of air-dried sample:							
Proximate—							
Moisture	do....			1.17	1.00	1.32	
Volatile matter	do....			17.83	18.80	18.28	
Fixed carbon	do....			68.12	67.03	67.26	
Ash	do....			12.88	13.17	13.14	
				100.00	100.00	100.00	
Ultimate—							
Hydrogen	do....			4.00			
Carbon	do....			75.68			
Nitrogen	do....			1.47			
Oxygen	do....			4.70			
Sulphur	do....			1.27	1.22	1.14	
Ash	do....			12.88			
				100.00			
Calorific value determined	calories..			7,450			
	B. T. U..			13,410			
Calorific value calculated from ultimate analysis	calories..			7,319			
	B. T. U..			13,174			
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent..	1.02	0.75	3.24	1.99	2.31	0.94
Volatile matter	do....	17.88	18.50	17.46	18.61	18.10	21.21
Fixed carbon	do....	73.61	73.77	66.69	66.36	66.58	67.65
Ash	do....	7.49	6.98	12.61	13.04	13.01	10.20
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do....			4.15			3.97
Carbon	do....			74.09			79.02
Nitrogen	do....			1.44			1.57
Oxygen	do....			6.47			3.51
Sulphur	do....			1.24	1.21	1.13	1.73
Ash	do....	1.10	1.15	12.61			10.20
				100.00			100.00
Calorific value determined	calories..	8,019					7,615
	B. T. U..	14,434					13,707

[a] Represents 38 tons of coal.

[b] Refuse from boiler test, laboratory No. 1106: Combustible, 18.08 per cent; ash, 81.92 per cent.

[c] Refuse from boiler test of briquettes, laboratory No. 1134: Combustible, 23.02 per cent; ash, 76.98 per cent.

Chemical analyses of Arkansas No. 2 coal.

[Lump coal from mine No. 12. Received from Central Coal and Coke Company, Bonanza, Ark.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 8.[b]	Sample of coal from coke test.	Sample of briquettes, boiler test No. 11.[c]
Laboratory sample number	1049	1053	1160	1100	1102	1112
Loss of moisture on air drying ... per cent.	....	....	1.50	0.40	1.50	4.00
Analysis of air-dried sample:						
Proximate—						
Moisture ... do.	....	....	.74	.67	.82	.92
Volatile matter ... do.	....	....	16.26	16.93	17.68	23.43
Fixed carbon ... do.	....	....	73.66	73.95	70.79	62.81
Ash ... do.	....	....	9.34	8.45	10.71	12.84
			100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen ... do.	....	....	4.13	....	....	4.12
Carbon ... do.	....	....	80.03	....	....	75.96
Nitrogen ... do.	....	....	1.40	....	....	1.52
Oxygen ... do.	....	....	3.20	....	....	4.18
Sulphur ... do.	....	....	1.90	1.96	1.60	1.38
Ash ... do.	....	....	9.34	....	....	12.84
			100.00			100.00
Calorific value determined ... calories	....	....	7,756	....	....	7,474
Calorific value determined ... B. T. U.	....	....	13,961	....	....	13,453
Calorific value calculated from ultimate analysis ... calories	....	....	7,794	....	....	7,409
Calorific value calculated from ultimate analysis ... B. T. U.	....	....	14,029	....	....	13,336
Analysis corrected to sample as received:						
Proximate—						
Moisture ... per cent.	0.95	0.78	2.23	1.07	2.31	4.88
Volatile matter ... do.	18.70	16.60	16.02	16.86	17.41	22.49
Fixed carbon ... do.	73.38	73.53	72.55	73.65	69.73	60.30
Ash ... do.	6.97	9.09	9.20	8.42	10.55	12.33
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen ... do.	....	....	4.24	....	....	4.40
Carbon ... do.	....	....	78.83	....	....	72.92
Nitrogen ... do.	....	....	1.38	....	....	1.46
Oxygen ... do.	....	....	4.48	....	....	7.57
Sulphur ... do.	2.12	2.50	1.87	1.95	1.58	1.32
Ash ... do.	....	....	9.20	....	....	12.33
			100.00			100.00
Calorific value determined ... calories	7,993	....	7,639	[d] 7,829	....	7,175
Calorific value determined ... B. T. U.	14,387	....	13,750	[d] 14,092	....	12,915

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[a] Represents one-half of a carload of coal.

[b] Refuse from boiler test, laboratory No. 1101: Combustible, 31.87 per cent; ash, 68.13 per cent.

[c] Refuse from boiler test of briquettes, laboratory No. 1113: Combustible, 10.55 per cent; ash, 89.45 per cent.

[d] Derived from determinations on carload sample.

Chemical analyses of Arkansas No. 3 coal.

[Lump and slack coal from mine No. 2a. Received from Western Coal and Mining Company, Jenny Lind, Ark.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.*a*	Sample from boiler test No. 25.*b*	Coke sample made from briquettes.	Sample of briquettes, boiler test No. 35.*c*
Laboratory sample number		1227	1228	1254	1254	1290	1293
Loss of moisture on air drying	per cent.	.80	1.06	1.40	1.08	....	1.60
Analysis of air-dried sample:							
Proximate—							
Moisture	do	.81	.58	.80	.90	....	1.02
Volatile matter	do	17.54	16.86	19.75	16.22	....	17.63
Fixed carbon	do	73.68	69.77	67.66	73.53	....	63.05
Ash	do	7.97	12.79	11.80	9.35	....	18.30
		100.00	100.00	100.00	100.00		100.00
Ultimate—							
Hydrogen	do			4.07			3.53
Carbon	do			76.37			71.72
Nitrogen	do			1.55			1.40
Oxygen	do			4.91			3.62
Sulphur	do	1.43	1.47	1.30	1.30	....	1.43
Ash	do			11.80			18.30
				100.00			100.00
Calorific value determined	calories	7,931	....	7,596	....	....	6,977
	B. T. U.	14,275	....	13,655	....	....	12,559
Calorific value calculated from ultimate analysis	calories		....	7,393	....	....	6,888
	B. T. U.		....	13,307	....	....	12,398
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent.	1.60	1.63	2.19	1.97	1.06	2.60
Volatile matter	do	17.40	16.68	19.47	16.04	2.80	17.35
Fixed carbon	do	73.09	69.03	66.71	72.74	72.73	62.04
Ash	do	7.91	12.66	11.63	9.25	23.42	18.01
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do			4.17			3.65
Carbon	do			75.31			70.57
Nitrogen	do			1.53			1.38
Oxygen	do			6.08			4.98
Sulphur	do	1.42	1.46	1.28	1.29	1.52	1.41
Ash	do			11.63			18.01
				100.00			100.00
Calorific value determined	calories	7,868	....	7,490	*d* 7,706	....	6,865
	B. T. U.	14,162	....	13,464	*d* 13,871	....	12,357

a Represents 11 tons of coal.
b Refuse from boiler test, laboratory No. 1255: Combustible, 42.19 per cent; ash, 57.81 per cent.
c Refuse from the boiler test of the briquette, laboratory No. 1292: Combustible, 14.27 per cent; ash, 85.73 per cent.
d Derived from the determinations on the carload sample.

Chemical analyses of Arkansas No. 4 coal.

[Slack coal from several Arkansas mines. Received from Western Coal and Mining Company, St. Louis, Mo.]

		Sample of briquettes, boiler test No. 40.[a]	Sample of briquettes, boiler test No. 42.[b]
Laboratory sample number		1320	1335
Loss of moisture on air drying	per cent..	2.10	0.10
Analysis of air-dried sample:			
Proximate—			
Moisture	do....	1.79	3.08
Volatile matter	do....	14.36	18.62
Fixed carbon	do....	73.52	66.10
Ash	do....	10.33	12.20
		100.00	100.00
Ultimate—			
Hydrogen	do....	3.64	4.15
Carbon	do....	79.43	75.91
Nitrogen	do....	1.40	1.28
Oxygen	do....	3.52	4.76
Sulphur	do....	1.68	1.70
Ash	do....	10.33	12.20
		100.00	100.00
Calorific value determined	calories..	7,612	7,487
	B. T. U..	13,402	13,477
Calorific value calculated from ultimate analysis	calories..	7,558	7,397
	B. T. U..	13,604	13,315
Analysis corrected to sample as received:			
Proximate—			
Moisture	per cent..	3.85	3.18
Volatile matter	do....	14.06	18.60
Fixed carbon	do....	71.98	66.08
Ash	do....	10.11	12.19
		100.00	100.00
Ultimate—			
Hydrogen	do....	3.80	4.15
Carbon	do....	77.76	75.83
Nitrogen	do....	1.37	1.28
Oxygen	do....	5.31	4.85
Sulphur	do....	1.65	1.70
Ash	do....	10.11	12.19
		100.00	100.00
Calorific value determined	calories..	7,452	7,480
	B. T. U..	13,414	13,464

[a] Refuse from the boiler test of the briquettes, laboratory No. 1319: Combustible, 46.40 per cent; ash, 53.60 per cent.
[b] Refuse from the boiler test of the briquettes, laboratory No. 1334: Combustible, 59.35 per cent; ash, 40.65 per cent.

Chemical analyses of Arkansas No. 5 coal.

[Lump and slack coal from mine No. 4. Received from Western Coal and Mining Company, Coalhill, Ark.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.	[illegible]
Laboratory sample number		[illegible]	[illegible]	[illegible]	[illegible]
Loss of moisture on air drying	per cent.	[illegible]	[illegible]	[illegible]	[illegible]
Analysis of air-dried sample:					
Proximate—					
Moisture	do	[illegible]	[illegible]	[illegible]	[illegible]
Volatile matter	do	[illegible]	[illegible]	[illegible]	[illegible]
Fixed carbon	do	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do	[illegible]	[illegible]	[illegible]	[illegible]
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do			[illegible]	
Carbon	do			[illegible]	
Nitrogen	do			[illegible]	
Oxygen	do			[illegible]	
Sulphur	do	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]	
				100.00	
Calorific value determined	Calories	[illegible]		[illegible]	
	B. T. U.	[illegible]		[illegible]	
Calorific value calculated from ultimate analysis	Calories			[illegible]	
	B. T. U.			[illegible]	
Analysis of coal as received:					
Proximate—					
Moisture	per cent.	[illegible]	[illegible]	[illegible]	[illegible]
Volatile matter	do	[illegible]	[illegible]	[illegible]	[illegible]
Fixed carbon	do	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do	[illegible]	[illegible]	[illegible]	[illegible]
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do			[illegible]	
Carbon	do			[illegible]	
Nitrogen	do			[illegible]	
Oxygen	do			[illegible]	
Sulphur	do	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]	
				100.00	
Calorific value determined	Calories	[illegible]		[illegible]	[illegible]
	B. T. U.	[illegible]		[illegible]	[illegible]

[illegible]

Chemical analyses of Arkansas No. 6 coal.

[Slack coal from mine No. 18. Received from Western Coal and Mining Company, Jenny Lind, Ark.

	Car sample.[a]	Sample of coal from coke test No. 55, coal and briquettes.	Sample of coal from coke test No. 58, coal washed.	Coke sample from coal and briquettes.[b]	Sample from washery test, unwashed, car sample.	Sample of washed coal.
Laboratory sample number	1542	1518	1538	1535	1542	1543
Loss of moisture on air drying .... per cent..	3.00	3.70	17.30	2.80	3.00	17.10
Analysis of air-dried sample:						
Proximate—						
Moisture .... do....	.82	.92	1.20	1.30	.82	1.54
Volatile matter .... do....	14.32	17.91	15.66	2.85	....	....
Fixed carbon .... do....	70.62	66.59	75.63	78.84	....	....
Ash .... do....	14.24	14.58	7.51	17.01	14.24	8.26
	100.00	100.00	100.00	100.00		
Ultimate—						
Sulphur .... do....	1.30	1.73	1.49	1.46	1.30	1.64
Phosphorus in coke	....	....	....	.05	....	....
Analysis corrected to sample as received:						
Proximate—						
Moisture .... per cent..	3.80	4.59	18.29	4.06	3.80	18.38
Volatile matter .... do....	13.89	17.25	12.95	2.77	....	....
Fixed carbon .... do....	68.50	64.12	62.54	76.63	....	....
Ash .... do....	13.81	14.04	6.22	16.54	13.81	6.85
	100.00	100.00	100.00	100.00		
Ultimate—						
Sulphur .... do....	1.26	1.68	1.22	1.43	1.26	1.36

[a] Represents 12 tons of coal.

[b] Specific gravity of the coke substance, 1.88; apparent specific gravity of the coke, 0.88; percentage of porosity, 0.53.

Chemical analyses of Colorado No. 1 coal.

[Run-of-mine black lignite from Simpson mine. Received from Northern Coal and Coke Company, Lafayette, Colo.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample (second portion).[b]	Sample from boiler test No. 75.[c]	Sample from gas-producer test No. 15.
Laboratory sample number		1383	1397	1523	1568	1541	1560
Loss of moisture on air drying	per cent..	3.90	4.00	6.00	9.20	5.40	7.80
Analysis of air-dried sample:							
Proximate—							
Moisture	do....	16.77	18.58	13.49	11.60	15.20	13.49
Volatile matter	do....	35.18	35.42	37.11	....	37.90	34.99
Fixed carbon	do....	44.29	42.38	43.03	....	41.22	45.17
Ash	do....	3.76	3.62	6.37	6.31	5.68	6.35
		100.00	100.00	100.00		100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	5.75	....	....	....
Carbon	do....	....	....	61.13	....	....	....
Nitrogen	do....	....	....	1.22	....	....	....
Oxygen	do....	....	....	24.95	....	....	....
Sulphur	do....	.54	.48	.58	.57	.44	.65
Ash	do....	....	....	6.37	....	....	....
				100.00			
Calorific value determined	calories..	5,918	....	5,995	....	....	5,885
	B. T. U..	10,652	....	10,791	....	....	10,593
Calorific value calculated from ultimate analysis	calories..	....	....	5,859	....	....	....
	B. T. U..	....	....	10,546	....	....	....
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent..	20.02	21.84	18.68	19.73	19.78	20.24
Volatile matter	do....	33.81	34.00	34.88	....	35.85	32.26
Fixed carbon	do....	42.56	40.68	40.45	....	39.00	41.65
Ash	do....	3.61	3.48	5.99	5.73	5.37	5.85
		100.00	100.00	100.00		100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	6.07	....	....	....
Carbon	do....	....	....	57.46	....	....	....
Nitrogen	do....	....	....	1.15	....	....	....
Oxygen	do....	....	....	28.78	....	....	....
Sulphur	do....	.52	.46	.55	.52	.42	.60
Ash	do....	....	....	5.99	....	....	....
				100.00			
Calorific value determined	calories..	5,687	....	5,635	....	5,606	[d]5,426
	B. T. U..	10,237	....	10,143	....	10,089	[d]9,767

[a] Represents 20 tons of coal.
[b] Represents 15 tons of coal.
[c] Refuse from the boiler test No. 75, laboratory No. 1540: Combustible, 62.94 per cent; ash, 37.06 per cent.
[d] Calorific value derived from determination on the carload sample: 5,524 calories; 9,943 B. T. U.

Chemical analyses of Illinois coal.

[Samples taken from a carload of coal furnished by the Consolidated Coal Company, St. Louis, Mo., from its mine at Bush, Williamson County, Ill. This coal was used in heating the boiler settings and getting the plant into operation.]

	Sample from boiler test (Aug. 22, 23, 1904).	Sample from boiler test.[a]
Laboratory sample number	1016	1021
Analysis corrected to sample as received:		
Proximate—		
Moisture ..... per cent	5.48	5.25
Volatile matter ..... do	36.22	36.00
Fixed carbon ..... do	47.70	47.30
Ash ..... do	10.60	11.45
	100.00	100.00
Ultimate—		
Hydrogen ..... do	5.17	....
Carbon ..... do	67.30	....
Nitrogen ..... do	1.24	....
Oxygen ..... do	11.99	....
Sulphur ..... do	3.70	3.00
Ash ..... do	10.60	....
	100.00	....
Calorific value determined ..... calories	6,812	[b]6,805
B. T. U.	12,262	[b]12,249

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[a] Refuse from boiler test, laboratory No. 1022 (August 22-26, 1904): Combustible, 25.02 per cent; ash, 74.98 per cent.

[b] Derived from the determinations on sample No. 1016.

Chemical analyses of Illinois No. 1 coal.

[Lump and nut coal from mine No. 1. Received from Western Anthracite Coal and Coke Company, O'Fallon, Ill.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 18.[b]	Sample of coal from coke test No. 10.
Laboratory sample number		1095	1096	1261	1168	1162
Loss of moisture on air drying	per cent..	4.40	3.20	3.70	3.00	2.50
Analysis of air-dried sample:						
Proximate—						
Moisture	do....	7.08	7.09	6.28	6.89	8.16
Volatile matter	do....	41.12	41.66	38.92	38.05	37.04
Fixed carbon	do....	41.00	40.85	41.08	39.40	38.44
Ash	do....	10.80	10.40	13.72	15.66	16.36
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do....	....	....	5.09	....	....
Carbon	do....	....	....	62.01	....	....
Nitrogen	do....	....	....	1.07	....	....
Oxygen	do....	....	....	13.86	....	....
Sulphur	do....	4.41	4.17	4.25	4.54	4.25
Ash	do....	....	....	13.72	....	....
				100.00		
Calorific value determined	calories..	6,521	....	6,360	....	....
	B. T. U..	11,738	....	11,448	....	....
Calorific value calculated from ultimate analysis	calories..	....	....	6,263	....	....
	B. T. U..	....	....	11,273	....	....
Analysis corrected to sample as received:						
Proximate—						
Moisture	per cent..	11.17	10.06	9.75	9.69	10.46
Volatile matter	do....	39.31	40.33	37.48	36.91	36.11
Fixed carbon	do....	39.20	39.54	39.57	38.21	37.48
Ash	do....	10.32	10.07	13.20	15.19	15.96
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do....	....	....	5.31	....	....
Carbon	do....	....	....	59.72	....	....
Nitrogen	do....	....	....	1.03	....	....
Oxygen	do....	....	....	16.64	....	....
Sulphur	do....	4.22	4.04	4.10	4.40	4.14
Ash	do....	....	....	13.20	....	....
				100.00		
Calorific value determined	calories..	6,235	....	6,125	[c]5,947	....
	B. T. U..	11,223	....	11,025	[c]10,705	....

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[a] Represents 15 tons of coal.

[b] Refuse from boiler test No. 18, laboratory No. 1167: Combustible, 18.22 per cent; ash, 81.78 per cent.

[c] Derived from the determinations on carload sample.

Chemical analyses of Illinois No. 2 coal.

[Slack coal from mine No. 1. Received from Western Anthracite Coal and Coke Company, O'Fallon, Ill.]

	Car sample.[a]	Sample from boiler test No. 19, washed coal.[b]	Sample of coal from coke test No. 9, washed coal.	Coke sample, washed coal.[c]	Sample from washery test, unwashed car sample.	Sample of washed slack coal.	Sample from washery test, refuse from washed slack.
Laboratory sample number	1152	1178	1159	1211	1152	1156	1155
Loss of moisture on air drying ....per cent..	7.10	5.00	10.10		7.10	12.40	12.50
Analysis of air-dried sample:							
Proximate—							
Moisture ....do....	5.31	5.74	7.91		5.31	7.61	3.99
Volatile matter ....do....	34.29	39.76	39.79				
Fixed carbon ....do....	36.24	43.92	42.08				
Ash ....do....	24.16	10.58	10.22		24.16	10.75	60.66
	100.00	100.00	100.00				
Ultimate—							
Hydrogen ....do....	4.57						
Carbon ....do....	54.06						
Nitrogen ....do....	.78						
Oxygen ....do....	12.13						
Sulphur ....do....	4.30	3.54	3.37		4.30	3.82	10.35
Ash ....do....	24.16						
	100.00						
Calorific value determined .... calories..	5,471						
B. T. U...	9,848						
Calorific value calculated from ultimate analysis .... calories..	5,516						
B. T. U...	9,929						
Analysis corrected to sample as received:							
Proximate—							
Moisture ....per cent..	12.03	10.45	17.20	1.57	12.03	19.07	15.99
Volatile matter ....do....	31.86	37.77	35.77	2.83			
Fixed carbon ....do....	33.67	41.72	37.84	75.42			
Ash ....do....	22.44	10.06	9.19	20.18	22.44	9.42	53.08
	100.00	100.00	100.00	100.00			
Ultimate—							
Hydrogen ....do....	5.04						
Carbon ....do....	50.22						
Nitrogen ....do....	.72						
Oxygen ....do....	17.58						
Sulphur ....do....	4.00	3.36	3.00	2.75	4.00	3.35	9.06
Phosphorus ....do....				.03			
Ash ....do....	22.44						
	100.00						
Calorific value determined .... calories..	5,083	[d]6,254					
B. T. U...	9,149	[d]11,257					

[a] Represents 14 tons of coal.

[b] Refuse from boiler test No. 19, laboratory No 1177: Combustible, 19.57 per cent washed coal; ash, 80.43 per cent washed coal.

[c] Specific gravity of the coke substance, 1.87; apparent specific gravity of the coke, 0.90; percentage of porosity, 0.52.

[d] Derived from determinations on carload sample.

Chemical analyses of Illinois No. 3 coal.

[Run-of-mine coal from mine No. 3. Received from Southern Illinois Coal Mining and Washing Company, Marion, Ill.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 38.[b]	Sample from gas-producer test No. 6.	Sample of coal from coke test No. 28, washed coal.	Sample of coal from coke test No. 29.	Coke sample, washed coal.[c]	Sample from washery test, unwashed car sample.	Sample of washed coal, from coke ovens.
Laboratory sample number	1170	1171	1318	1310	1340	1326	1337	1343	1318	1326
Loss of moisture on air drying, per cent	1.50	1.80	2.70	1.70	1.50	2.70	1.70	5.20	2.70	2.70
Analysis of air-dried sample.										
Proximate—										
Moisture ....per cent..	6.09	5.63	5.96	6.92	6.21	7.01	6.67	.96	5.96	7.01
Volatile matter ......do....	32.16	34.92	30.29	31.73	31.34	32.94	30.73	.44		
Fixed carbon ....do....	54.49	51.78	52.16	49.61	52.57	54.03	51.82	87.08		
Ash ....do....	7.26	7.67	11.59	11.74	9.88	6.02	10.78	11.52	11.59	6.02
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen ....do....			4.92							
Carbon ....do....			67.30							
Nitrogen ....do....			1.43							
Oxygen ....do....			12.99							
Sulphur ....do....	1.00	2.08	1.77	1.53	1.72	1.45	1.47	1.19	1.77	1.45
Ash ....do....			11.59							
			100.00							
Calorific value determined — calories..	6,986		6,724		6,794					
Calorific value determined — B. T. U..	12,565		12,103		12,229					
Calorific value calculated from ultimate analysis — calories..			6,615							
Calorific value calculated from ultimate analysis — B. T. U..			11,907							
Phosphorus in coke								.019		
Analysis corrected to sample as received:										
Proximate—										
Moisture ....per cent..	7.50	7.34	8.50	8.51	7.62	9.52	8.25	6.11	8.50	9.52
Volatile matter ......do....	31.68	34.29	29.47	31.19	30.87	32.06	30.22	.42		
Fixed carbon ....do....	53.67	50.84	50.75	48.75	51.78	52.57	50.94	82.25		
Ash ....do....	7.15	7.53	11.28	11.55	9.73	5.86	10.59	10.92	11.28	5.06
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen ....do....			5.09							
Carbon ....do....			65.48							
Nitrogen ....do....			1.39							
Oxygen ....do....			15.04							
Sulphur ....do....	.99	2.04	1.72	1.50	1.69	1.41	1.45	1.13	1.72	1.41
Ash ....do....			11.28							
			100.00							
Calorific value determined — calories..	6,881		6,542	[d]6,533	[e]6,692					
Calorific value determined — B. T. U..	12,386		11,776	[d]11,759	[e]12,046					

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[a] Represents 40 tons of coal.

[b] Refuse from boiler test No. 38, laboratory No. 1309: Combustible, 33.73 per cent; ash, 66.27 per cent.

[c] Specific gravity of the coke substance, 1.84; apparent specific gravity of the coke, 0.82; percentage of porosity, 0.55.

[d] Derived from the determinations on the carload sample.

[e] Calorific value derived from determinations on the carload sample: 6,744 calories; 12,139 B. T. U.

Chemical analyses of Illinois No. 4 coal.

[Lump coal from mine No. 3. Received from Donk Brothers Coal and Coke Company, Troy, Ill.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 48.[b]	Sample from boiler test No. 50.[c]	Sample from gas-producer test No. 9.
Laboratory sample number	1341	1342	1417	1385	1395	1405
Loss of moisture on air drying, per cent	3.20	3.00	1.70	1.40	0.40	2.70
Analysis of air-dried sample:						
Proximate—						
Moisture, do	12.28	11.77	11.40	12.24	12.23	10.00
Volatile matter, do	32.02	33.18	32.45	33.96	32.57	33.55
Fixed carbon, do	48.03	45.97	44.30	42.18	43.80	46.97
Ash, do	7.67	9.08	11.85	11.62	11.40	9.48
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen, do	....	....	5.33	....	....	....
Carbon, do	....	....	61.79	....	....	....
Nitrogen, do	....	....	1.17	....	....	....
Oxygen, do	....	....	18.52	....	....	....
Sulphur, do	.86	1.57	1.34	1.30	1.36	1.45
Ash, do	....	....	11.85	....	....	....
			100.00			
Calorific value determined, calories	6,400	....	6,105	....	....	6,416
Calorific value determined, B. T. U.	11,520	....	10,991	....	....	11,549
Calorific value calculated from ultimate analysis, calories	....	....	6,062	....	....	....
Calorific value calculated from ultimate analysis, B. T. U.	....	....	10,912	....	....	....
Analysis corrected to sample as received:						
Proximate—						
Moisture, per cent	15.09	14.42	12.91	13.47	12.58	12.43
Volatile matter, do	31.00	32.18	31.90	33.48	32.44	32.65
Fixed carbon, do	46.49	44.59	43.55	41.59	43.63	45.70
Ash, do	7.42	8.81	11.64	11.46	11.35	9.22
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen, do	....	....	5.43	....	....	....
Carbon, do	....	....	60.74	....	....	....
Nitrogen, do	....	....	1.15	....	....	....
Oxygen, do	....	....	19.72	....	....	....
Sulphur, do	.83	1.52	1.32	1.28	1.36	1.41
Ash, do	....	....	11.64	....	....	....
			100.00			
Calorific value determined, calories	6,195	....	6,002	[d]5,973	[c]6,050	[e]6,243
Calorific value determined, B. T. U.	11,151	....	10,804	[d]10,751	[c]10,890	[e]11,237

[a] Represents 22 tons of coal.

[b] Refuse from boiler test No. 48, laboratory No. 1386: Combustible, 16.61 per cent; ash, 83.39 per cent.

[c] Refuse from the boiler test No. 50, laboratory No. 1396: Combustible, 19.56 per cent; ash, 80.44 per cent.

[d] Derived from the determinations on the carload sample.

[e] Calorific value derived from determinations on the carload sample: 6,231 calories; 11,216 B. T. U.

Chemical analyses of Illinois No. 5 coal.

[Washed slack coal from mine No. 1. Received from Donk Brothers Coal and Coke Company, Collinsville, Ill.]

		Car sample.[a]	Sample of coal from coke test No. 46, washed coal.	Sample of coal from coke test No. 50, washed coal.	Sample of coal from coke test No. 40, washed coal.	Sample from washery test, rewashed.	Sample of washed coal car sample.
Laboratory sample number		1556	1454	1546	1554	1560	1556
Loss of moisture on air drying	per cent..	22.50	4.20	23.30	7.38	23.50	22.50
Analysis of air-dried sample:							
Proximate—							
Moisture	do...	5.26	3.63	7.46	7.57	6.46	5.16
Volatile matter	do...	34.88	34.92	35.67	33.24	....	....
Fixed carbon	do...	30.57	30.25	45.77	30.38	....	......
Ash	do...	29.29	29.32	22.34	29.30	20.48	29.29
		100.00	100.00	100.00	100.00		
Ultimate—							
Hydrogen	do.	4.59	....	....	....	....	....
Carbon	do...	56.82	....	....	....	....	....
Sulphur	do...	3.76	3.56	3.36	3.72	3.29	3.76
Ash	do...	29.29	....	....	....	....	....
Calorific value determined	calories..	5,817	....	....	....	....	....
	B. T. U..	10,451	....	....	....	....	....
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent..	27.82	27.46	25.15	24.40	28.46	27.02
Volatile matter	do..	40.50	11.55	25.58	30.78	....	....
Fixed carbon	do.	15.50	22.48	30.49	36.48	....	....
Ash	do...	16.79	17.56	8.78	18.16	7.25	16.79
		100.00	100.00	100.00	100.00		
Ultimate—							
Hydrogen	do.	5.50	....	....	....	....	....
Carbon	do.	50.77	....	....	....	....	....
Sulphur	do.	3.29	3.25	2.77	1.44	2.52	3.29
Ash	do.	16.79	....	....	....	....	....
Calorific value determined	calories.	4,77[illegible]	....	....	....	....	....
	B. T. U.	8,0[illegible]	....	....	....	....	....

[a] Represents [illegible] tons of coal.

Chemical analyses of Illinois No. 6 coal.

[Run-of-mine coal from shaft No. 1. Received from Clover Leaf Coal Company, Coffeen, Ill.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 73.[b]	Sample from washery test, unwashed.
Laboratory sample number	1449	1450	1557	1533	1569
Loss of moisture on air drying .... per cent..	5.60	4.00	9.80	5.80	10.00
Analysis of air-dried sample:					
Proximate—					
Moisture .... do....	9.84	10.35	5.13	7.84	6.18
Volatile matter .... do....	36.86	35.35	32.68	34.81	....
Fixed carbon .... do....	44.96	42.94	47.46	42.06	....
Ash .... do....	8.34	11.36	14.73	15.79	13.30
	100.00	100.00	100.00	100.00	
Ultimate—					
Hydrogen .... do....	....	....	4.88	....	....
Carbon .... do....	....	....	60.51	....	....
Nitrogen .... do....	....	....	1.23	....	....
Oxygen .... do....	....	....	14.20	....	....
Sulphur .... do....	3.82	3.95	4.45	3.70	4.08
Ash .... do....	....	....	14.73	....	....
			100.00		
Calorific value determined .... calories..	6,483	....	6,199	....	....
B. T. U..	11,669	....	11,158	....	....
Calorific value calculated from ultimate analysis ... calories..	....	....	6,059	....	....
B. T. U..	....	....	10,906	....	....
Analysis corrected to sample as received:					
Proximate—					
Moisture .... per cent..	14.89	13.94	14.43	13.19	15.56
Volatile matter .... do....	34.80	33.93	29.48	32.31	....
Fixed carbon .... do....	42.44	41.22	42.81	39.62	....
Ash .... do....	7.87	10.91	13.28	14.88	11.97
	100.00	100.00	100.00	100.00	
Ultimate—					
Hydrogen .... do....	....	....	5.49	....	....
Carbon .... do....	....	....	54.59	....	....
Nitrogen .... do....	....	....	1.11	....	....
Oxygen .... do....	....	....	21.52	....	....
Sulphur .... do....	3.61	3.79	4.01	3.48	3.67
Ash .... do....	....	....	13.28	....	....
			100.00		
Calorific value determined .... calories..	6,120	....	5,591	[c] 5,593	....
B. T. U..	11,016	....	10,064	[c] 10,067	....

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[a] Represents 17 tons of coal.

[b] Refuse from the boiler test No. 73, laboratory No. 1532: Combustible, 15.84 per cent; ash, 84.16 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Indiana No. 1 coal.

[Run-of-mine coal from Mildred mine. Received from J. Wooley Coal Company, Mildred, Ind.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 68, washed coal.[b]	Sample from gas-producer test No. 14.	Sample of coal from coke test No. 51, washed coal.	Coke sample from washed coal.[c]	Sample from washery test, unwashed, car sample.	Sample of washed coal.	Sample from washery test, refuse.	Sample of briquettes, boiler test No. 71, washed coal.[d]
Laboratory sample number		1410	1412	1507	1498	1512	1497	1511	1507	1502	1501	1521
Loss of moisture on air drying, per cent		8.70	5.60	3.00	8.40	4.80	6.00	4.60	3.00	7.20	8.20	4.20
Analysis of air-dried sample:												
Proximate—												
Moisture	per cent	4.98	6.25	8.66	8.96	7.05	11.20	1.16	8.66	10.26	7.24	7.86
Volatile matter	do	39.22	37.10	34.86	38.40	37.85	38.70	1.24				40.49
Fixed carbon	do	45.76	46.46	42.67	44.11	44.51	42.61	84.41				45.14
Ash	do	10.04	10.19	13.81	8.54	10.59	7.49	13.19	13.81	7.72	34.54	6.51
		100.00	100.00	100.00	100.00	100.00	100.00	100.00				100.00
Ultimate—												
Hydrogen	do			5.20								5.39
Carbon	do			62.30								69.82
Nitrogen	do			1.22								1.36
Oxygen	do			14.90								14.81
Sulphur	do	2.05	1.02	2.58	2.38	2.74	2.16	1.77	2.58	2.40	6.18	2.11
Ash	do			13.81								6.51
				100.00								100.00
Calorific value determined	calories	6,912		6,336		6,731						6,980
	B. T. U.	12,442		11,405		12,116						12,564
Calorific value calculated from ultimate analysis	calories			6,231								6,908
	B. T. U.			11,216								12,434
Phosphorus in coke								.016				
Analysis corrected to sample as received:												
Proximate—												
Moisture	per cent	13.25	11.50	11.40	16.59	11.51	16.53	5.71	11.40	16.72	14.85	11.74
Volatile matter	do	35.81	35.02	33.81	35.17	36.04	36.38	1.18				38.79
Fixed carbon	do	41.78	43.86	41.39	40.41	42.37	40.05	80.52				43.23
Ash	do	9.16	9.62	13.40	7.83	10.08	7.04	12.59	13.40	7.16	31.71	6.24
		100.00	100.00	100.00	100.00	100.00	100.00	100.00				100.00
Ultimate—												
Hydrogen	do			5.37								5.63
Carbon	do			60.34								66.88
Nitrogen	do			1.18								1.30
Oxygen	do			17.21								17.92
Sulphur	do	1.87	.96	2.50	2.18	2.61	2.03	1.69	2.50	2.23	5.67	2.03
Ash	do			13.40								6.24
				100.00								100.00
Calorific value determined	calories	6,311		6,146	6,200	[f]6,408						6,687
	B. T. U.	11,360		11,063	[e]11,160	[f]11,534						12,037

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[a] Represents 40 tons of coal.

[b] Refuse from boiler test, laboratory No. 1500. Combustible, [illegible] per cent; ash, [illegible] per cent.

[c] Specific gravity of the coke substance, 1.86; apparent specific gravity of coke, [illegible]; percentage of porosity, 0.51 [illegible]

[d] Refuse from the boiler test on the briquettes, laboratory No. [illegible]. Combustible, [illegible] per cent; ash, [illegible] per cent.

[e] [illegible]

[f] Calorific value derived from [illegible] coal sample, [illegible] calories, [illegible] B. T. U.

Chemical analyses of Indiana No. 2 coal.

[Run-of-mine coal from Electric mine. Received from T. D. Scales Company, Boonville, Ind.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 65.[b]	Sample from gas-producer test No. 13.
Laboratory sample number		1425	1426	1495	1487	1496
Loss of moisture on air drying	per cent	2.80	3.10	3.60	2.00	2.60
Analysis of air-dried sample:						
Proximate—						
Moisture	do	6.67	7.45	6.24	7.25	6.29
Volatile matter	do	40.53	39.30	37.49	38.82	40.66
Fixed carbon	do	43.19	44.43	42.76	41.22	43.06
Ash	do	9.61	8.82	13.51	12.71	9.99
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do			5.11		
Carbon	do			62.97		
Nitrogen	do			1.25		
Oxygen	do			12.56		
Sulphur	do	4.57	3.62	4.60	4.20	4.34
Ash	do			13.51		
				100.00		
Calorific value determined	calories	6,744		6,410		6,743
	B. T. U.	12,139		11,538		12,137
Calorific value calculated from ultimate analysis	calories			6,411		
	B. T. U.			11,540		
Analysis corrected to sample as received:						
Proximate—						
Moisture	per cent	9.28	10.32	9.62	9.11	8.72
Volatile matter	do	39.40	38.08	36.14	38.04	39.60
Fixed carbon	do	41.98	43.05	41.22	40.40	41.95
Ash	do	9.34	8.55	13.02	12.45	9.73
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do			5.33		
Carbon	do			60.70		
Nitrogen	do			1.20		
Oxygen	do			15.32		
Sulphur	do	4.44	3.51	4.43	4.12	4.23
Ash	do			13.02		
				100.00		
Calorific value determined	calories	6,555		6,179	[c] 6,289	[d] 6,568
	B. T. U.	11,799		11,122	[c] 11,320	[d] 11,822

[a] Represents 39 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1485: Combustible, 17.24 per cent; ash, 82.76 per cent.

[c] Derived from the determinations on the carload sample.

[d] Calorific value derived from determinations on the carload sample: 6,541 calories; 11,774 B. T. U.

Chemical analyses of Indian Territory No. 1 coal.

[Lump and slack coal from mine No. 1. Received from Whitehead Coal and Mining Company, Henryetta, Ind. T.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 10.[b]	Sample from gas-producer test.	Sample of coal from coke test No. 6.
Laboratory sample number		1059	1060	1138	1110	1163	1132
Loss of moisture on air drying	per cent..	5.00	3.10	3.30	3.80	1.20	7.10
Analysis of air-dried sample.							
Proximate—							
Moisture	do....	4.07	3.79	3.87	4.00	3.85	3.44
Volatile matter	do....	36.65	37.41	35.73	35.30	36.95	33.86
Fixed carbon	do....	50.20	52.94	50.05	48.13	50.59	47.78
Ash	do....	9.08	5.86	10.35	12.57	8.61	14.92
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	5.14	....	....	....
Carbon	do....	....	....	69.86	....	....	....
Nitrogen	do....	....	....	1.29	....	....	....
Oxygen	do....	....	....	11.38	....	....	....
Sulphur	do....	1.71	1.40	1.98	1.87	1.45	1.45
Ash	do....	....	....	10.35	....	....	....
				100.00			
Calorific value determined	calories..	7,073	....	7,011	....	7,250	....
	B. T. U..	12,731	....	12,620	....	13,050	....
Calorific value calculated from ultimate analysis	calories..	....	....	6,971	....	....	....
	B. T. U..	....	....	12,548	....	....	....
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent..	8.87	6.77	7.04	7.65	5.00	10.29
Volatile matter	do....	34.82	36.25	34.55	33.96	36.51	31.46
Fixed carbon	do....	47.68	51.30	48.40	46.30	49.98	44.39
Ash	do....	8.63	5.68	10.01	12.09	8.51	13.86
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	5.34	....	....	....
Carbon	do....	....	....	67.55	....	....	....
Nitrogen	do....	....	....	1.25	....	....	....
Oxygen	do....	....	....	13.93	....	....	....
Sulphur	do....	1.62	1.36	1.92	1.80	1.43	1.34
Ash	do....	....	....	10.01	....	....	....
				100.00			
Calorific value determined	calories..	6,720	....	6,779	[c]6,584	[d]7,162	....
	B. T. U..	12,096	....	12,202	[c]11,851	[d]12,892	....

[a] Represents 40 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1111: Combustible, 32.23 per cent; ash, 67.77 per cent.

[c] Derived from the determinations on the carload sample.

[d] Calorific value derived from determinations on the carload sample: 7,104 calories; 12,787 B. T. U.

Chemical analyses of Indian Territory No. 2 coal.

[Run-of-mine coal from mine No. 8. Received from Rock Island Coal Company, Hartshorne, Ind. T.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 20.[b]	Sample of coal from coke test No. 11.	Sample of coal from coke test No. 12, washed coal.
Laboratory sample number		1071	1073	1184	1181	1169	1179
Loss of moisture on air drying	per cent.	....	....	2.80	2.00	2.20	2.90
Analysis of air-dried sample:							
Proximate—							
Moisture	do.	....	....	1.70	1.75	1.66	1.58
Volatile matter	do.	....	....	37.19	36.95	38.29	39.32
Fixed carbon	do.	....	....	49.79	51.33	49.84	52.58
Ash	do.	....	....	11.32	9.97	10.21	6.52
				100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.	....	....	5.00	....	....	....
Carbon	do.	....	....	71.49	....	....	....
Nitrogen	do.	....	....	1.72	....	....	....
Oxygen	do.	....	....	8.91	....	....	....
Sulphur	do.	....	....	1.56	1.42	1.50	1.47
Ash	do.	....	....	11.32	....	....	....
				100.00			
Calorific value determined	calories.	....	....	7,205	....	....	....
	B. T. U.	....	....	12,969	....	....	....
Calorific value calculated from ultimate analysis	calories.	....	....	7,152	....	....	....
	B. T. U.	....	....	12,874	....	....	....
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent.	1.46	1.30	4.45	3.71	3.82	4.45
Volatile matter	do.	39.04	38.90	36.15	36.21	37.45	38.18
Fixed carbon	do.	53.10	52.15	48.40	50.31	48.74	51.04
Ash	do.	6.40	7.65	11.00	9.77	9.99	6.33
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.	....	....	5.17	....	....	....
Carbon	do.	....	....	69.49	....	....	....
Nitrogen	do.	....	....	1.67	....	....	....
Oxygen	do.	....	....	11.15	....	....	....
Sulphur	do.	1.38	1.58	1.52	1.39	1.47	1.43
Phosphorus in coke	do.	....	....	....	....	....	....
Ash	do.	....	....	11.00	....	....	....
				100.00			
Calorific value determined	calories.	7,800	....	7,004	[c]7,176	....	....
	B. T. U.	14,040	....	12,607	[c]12,917	....	....

[a] Represents 20 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1182: Combustible, 20.96 per cent; ash, 79.04 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Indian Territory No. 2 coal—Continued.

[Run-of-mine coal from mine No 8. Received from Rock Island Coal Company, Hartshorne, Ind. T.]

	Coke sample, washed coal.[e]	Sample from washery test, coarse, screened, unwashed coal.	Sample of washed coal, coarse coal.	Coke sample, unwashed coal.[d]	Sample from washery test, coarse, refuse coal.	Sample from washery test, fine-screened washed coal.
Laboratory sample number	1219	1183	1180	1212	1192	1223
Loss of moisture on air drying ... per cent				5.70		19.40
Analysis of air dried sample:						
Proximate—						
Moisture ... do		0.91	1.51	2.60	2.21	2.13
Volatile matter ... do				1.85		
Fixed carbon ... do				80.25		
Ash ... do		9.95	6.27	15.30	44.06	6.00
				100.00		
Ultimate—						
Hydrogen ... do						
Carbon ... do						
Nitrogen ... do						
Oxygen ... do						
Sulphur ... do		1.59	1.96	1.58	5.56	1.18
Ash ... do						
Calorific value determined ... calories						
Calorific value determined ... B. T. U.						
Calorific value calculated from ultimate analysis ... calories						
Calorific value calculated from ultimate analysis ... B. T. U.						
Phosphorus in coke				.05		
Analysis corrected to sample as received:						
Proximate—						
Moisture ... per cent	0.96			8.15		21.13
Volatile matter ... do	2.59			1.74		
Fixed carbon ... do	85.33			75.68		
Ash ... do	11.12			14.43		4.84
	100.00			100.00		
Ultimate—						
Hydrogen ... do						
Carbon ... do						
Nitrogen ... do						
Oxygen ... do						
Sulphur ... do	1.75			1.50		.95
Phosphorus in coke ... do	0.048					
Ash ... do						
Calorific value determined ... calories						
Calorific value determined ... B. T. U.						

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[d] Specific gravity of the coke substance, 1.88; apparent specific gravity of the coke, 0.89; percentage of porosity, 53.
[e] Specific gravity of the coke substance, 1.82; apparent specific gravity of the coke, 0.89; percentage of porosity, 51.

Chemical analyses of Indian Territory No. 3 coal.

[Run-of-mine coal from mine No. 1. Received from D. Edwards & Son, Edwards, Ind. T.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 32.[b]	Sample of coal from coke test No. 21.	Sample of coal from coke test No. 22, washed coal.	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1079	1080	1274	1276	1266	1272	1274	1272
Loss of moisture on air drying..per cent..	....	....	1.20	1.10	1.20	2.40	1.20	2.40
Analysis of air-dried sample:								
Proximate—								
Moisture..........do....	....	....	3.45	3.73	3.00	3.61	3.45	3.61
Volatile matter..........do....	....	....	37.45	37.72	37.10	38.99	....	....
Fixed carbon..........do....	....	....	47.82	48.11	50.03	49.73	....	....
Ash..........do....	....	....	11.28	10.44	9.87	7.67	11.28	7.67
			100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen..........do....	....	....	4.85	....	....	....	....	....
Carbon..........do....	....	....	68.18	....	....	....	....	....
Nitrogen..........do....	....	....	1.50	....	....	....	....	....
Oxygen..........do....	....	....	10.52	....	....	....	....	....
Sulphur..........do....	....	....	3.67	3.97	3.20	3.27	3.67	3.27
Ash..........do....	....	....	11.28	....	....	....	....	....
			100.00					
Calorific value determined..... calories..	....	....	6,927	....	....	....	....	....
Calorific value determined..... B. T. U...	....	....	12,469	....	....	....	....	....
Calorific value calculated from ultimate analysis..... calories..	....	....	6,811	....	....	....	....	....
Calorific value calculated from ultimate analysis..... B. T. U...	....	....	12,258	....	....	....	....	....
Analysis corrected to sample as received:								
Proximate—								
Moisture..........per cent..	2.97	2.93	4.61	4.79	4.16	5.93	4.61	5.93
Volatile matter..........do....	40.43	39.02	37.00	37.30	36.66	38.05	....	....
Fixed carbon..........do....	48.22	47.75	47.25	47.58	49.43	48.53	....	....
Ash..........do....	8.38	10.30	11.14	10.33	9.75	7.49	11.14	7.49
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen..........do....	....	....	4.92	....	....	....	....	....
Carbon..........do....	....	....	67.37	....	....	....	....	....
Nitrogen..........do....	....	....	1.48	....	....	....	....	....
Oxygen..........do....	....	....	11.46	....	....	....	....	....
Sulphur..........do....	3.05	3.73	3.63	3.93	3.16	3.20	3.63	3.20
Ash..........do....	....	....	11.14	....	....	....	....	....
			100.00					
Calorific value determined..... calories..	6,995	....	6,844	[c] 6,877	....	....	....	....
Calorific value determined..... B. T. U...	12,591	....	12,319	[c] 12,379	....	....	....	....

[a] Represents 25 tons of coal.

[b] Refuse from boiler test, laboratory No. 1277: Combustible, 22.40 per cent; ash, 77.60 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Indian Territory No. 4 coal.

[Lump coal from mine No. 5. Received from Western Coal and Mining Company, Lehigh, Ind. T.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample (second portion).[a]	Sample from boiler test No. 52.[b]
Laboratory sample number		1150	1151	1470	1608	1408
Loss of moisture on air drying	per cent..	1.60	1.90	1.40	5.00	1.40
Analysis of air-dried sample:						
Proximate—						
Moisture	do....	3.75	4.69	4.91	3.53	4.91
Volatile matter	do....	38.15	39.76	37.79	37.37	35.94
Fixed carbon	do....	45.77	46.06	43.90	45.87	45.98
Ash	do....	12.33	9.49	13.40	13.23	13.17
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do....			4.84		
Carbon	do....			63.21		
Nitrogen	do....			1.38		
Oxygen	do....			13.15		
Sulphur	do....	3.83	3.74	4.02	3.99	3.91
Ash	do....			13.40		
				100.00		
Calorific value determined	calories..		6,708	6,327		
	B. T. U..		12,071	11,389		
Calorific value calculated from ultimate analysis	calories..			6,300		
	B. T. U..			11,340		
Analysis of sample as received:						
Proximate—						
Moisture	per cent..	5.29	6.50	6.24	8.35	6.24
Volatile matter	do....	37.54	39.01	37.26	35.50	35.44
Fixed carbon	do....	45.04	45.18	43.29	43.58	45.33
Ash	do....	12.13	9.31	13.21	12.57	12.99
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do....			4.93		
Carbon	do....			62.34		
Nitrogen	do....			1.36		
Oxygen	do....			14.20		
Sulphur	do....	3.77	3.67	3.96	3.79	3.86
Ash	do....			13.21		
				100.00		
Calorific value determined	calories..		6,579	6,238		[c]6,264
	B. T. U..		11,842	11,228		[c]11,275

[illegible] No. 1404. Combustible, 15.94 per cent; ash, 84.06 per cent.
[illegible] the carload sample.

Chemical analyses of Indian Territory No. 5 coal.

[Slack and pea coal mixed, mine No. 7. Received from Western Coal and Mining Company, Lehigh, Ind. T.]

		Car sample.[a]	Sample of coal from coke test No. 48, washed coal.	Sample from washery test, unwashed car sample.	Sample of washed coal.	Sample from the washery test, refuse.
Laboratory sample number		1481	1476	1481	1492	1482
Loss of moisture on air drying	per cent..	2.70	12.80	2.70	12.30	14.70
Analysis of air-dried sample:						
Proximate—						
Moisture	do....	5.74	4.76	5.74	4.80	5.87
Volatile matter	do....	31.46	38.19			
Fixed carbon	do....	37.05	47.72			
Ash	do....	25.75	9.33	25.75	8.80	49.23
		100.00	100.00			
Ultimate—						
Hydrogen	do....	4.18				
Carbon	do....	52.39				
Nitrogen	do....	1.22				
Oxygen	do....	12.40				
Sulphur	do....	4.06	3.32	4.06	3.20	5.90
Ash	do....	25.75				
		100.00				
Calorific value determined	calories..	5,201				
	B. T. U..	9,362				
Calorific value calculated from ultimate analysis	calories..	5,231				
	B. T. U..	9,416				
Analysis corrected to sample as received:						
Proximate—						
Moisture	per cent..	8.29	16.95	8.29	16.51	19.71
Volatile matter	do....	30.61	33.30			
Fixed carbon	do....	36.05	41.61			
Ash	do....	25.05	8.14	25.05	7.72	41.99
		100.00	100.00			
Ultimate—						
Hydrogen	do....	4.37				
Carbon	do....	50.98				
Nitrogen	do....	1.19				
Oxygen	do....	14.46				
Sulphur	do....	3.95	2.90	3.95	2.81	5.03
Ash	do....	25.05				
		100.00				
Calorific value determined	calories..	5,061				
	B. T. U..	9,110				

[a] Represents 20 tons of coal.

Chemical analyses of Indian Territory [illegible]

[Sample taken from [illegible] Owned [illegible] Development Company, [illegible] Ind. T.]

	Car sample.*
Laboratory number	[illegible]
Loss of moisture on air-drying .... per cent..	3.[illegible]
Analysis of air-dried sample:	
Proximate—	
Moisture .... do	4.[illegible]
Volatile matter .... do	32.41
Fixed carbon .... do	42.91
Ash .... do	19.99
	100.00
Ultimate—	
Sulphur .... do....	3.32
Analysis corrected to sample as received:	
Proximate—	
Moisture .... do	[illegible]
Volatile matter .... do....	3[illegible].25
Fixed carbon .... do....	41.[illegible]0
Ash .... do...	19.[illegible]9
	100.00
Ultimate—	
Sulphur .... do....	3.[illegible]0

* Represents first 4 tons taken from car.

Chemical analyses of Iowa No. 1 coal.

[Lump and fine coal from mine No. 2. Received from Anchor Coal Company, Laddsdale, Iowa.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.	Sample from boiler test No. 45.[a]	Sample of coal from coke test No. 31, washed coal.	Coke sample, washed coal.[b]	Sample from washery test, unwashed car sample.	Sample of washed coal, from coke ovens.
Laboratory sample number	1270	1271	1347	1357	1356	1371	1347	1356
Loss of moisture on air drying..per cent..	7.90	8.00	3.20	2.30	4.30	8.60	3.20	4.30
Analysis of air-dried sample:								
Proximate—								
Moisture....do....	3.74	4.43	5.21	6.54	8.92	2.11	5.21	8.92
Volatile matter....do....	41.96	40.52	31.76	33.86	37.53	1.79		
Fixed carbon....do....	42.89	41.65	46.51	40.83	42.84	77.01		
Ash....do....	11.41	13.40	16.52	18.77	10.71	19.09	16.52	10.71
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen....do....			4.61					
Carbon....do....			61.80					
Nitrogen....do....			.97					
Oxygen....do....			10.90					
Sulphur....do....	5.12	5.42	5.20	6.54	4.82	4.25	5.20	4.82
Ash....do....			16.52					
			100.00					
Calorific value determined.....calories..	6,843		6,329					
Calorific value determined.....B. T. U..	12,317		11,392					
Calorific value calculated from ultimate analysis.....calories..			6,230					
Calorific value calculated from ultimate analysis.....B. T. U..			11,214					
Phosphorus in coke						.051		
Analysis corrected to sample as received:								
Proximate—								
Moisture....per cent..	11.35	12.07	8.24	8.69	12.84	10.53	8.24	12.84
Volatile matter....do....	38.65	37.28	30.74	33.08	35.91	1.63		
Fixed carbon....do....	39.49	38.32	45.02	39.89	41.00	70.39		
Ash....do....	10.51	12.33	16.00	18.34	10.25	17.45	16.00	10.25
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen....do....			4.81					
Carbon....do....			59.82					
Nitrogen....do....			.94					
Oxygen....do....			13.40					
Sulphur....do....	4.72	4.99	5.03	6.39	4.61	3,89	5.03	4.61
Ash....do....			16.00					
			100.00					
Calorific value determined.....calories..	6,303		6,126	[c]5,805				
Calorific value determined.....B. T. U..	11,345		11,027	[c]10,449				

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[a] Refuse from boiler test, laboratory No. 1358: Combustible, 13.12 per cent; ash, 86.88 per cent.

[b] Specific gravity of the coke substance, 1.87; apparent specific gravity of the coke, 0.93; percentage of porosity, 51 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Iowa No. 2 coal.

[Run-of-mine coal from mine No. 6. Received from Mammoth Vein Coal Company, Hamilton, Iowa.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample (second portion).[b]	Sample from boiler test No. 67.[c]	Sample from gas-producer test No. 22.	Sample of coal from coke test No. 49, washed coal.	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1289	1291	1570	1608	1490	1611	1483	1570	1483
Loss of moisture on air drying, per cent	9.30	9.50	10.40	15.50	10.40	14.90	10.10	10.40	10.10
Analysis of air-dried sample:									
Proximate—									
Moisture, per cent	7.00	6.63	4.25	1.76	5.00	2.10	9.73	4.25	9.73
Volatile matter, do	40.65	40.82	37.02	39.09	39.45	36.92	39.42		
Fixed carbon, do	39.52	42.40	41.74	42.04	37.65	36.66	39.41		
Ash, do	12.83	10.15	16.99	17.11	17.90	24.32	11.44	16.99	11.44
	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—									
Hydrogen, do			4.84						
Carbon, do			60.36						
Nitrogen, do			1.46						
Oxygen, do			11.15						
Sulphur, do	5.49	5.74	5.20	6.09	5.28	6.40	4.37	5.20	4.37
Ash, do			16.99						
Calorific value determined, calories	6,302		6,212						
Calorific value determined, B. T. U.	11,344		11,182						
Calorific value calculated from ultimate analysis, calories			6,183						
Calorific value calculated from ultimate analysis, B. T. U.			11,129						
Analysis corrected to sample as received:									
Proximate—									
Moisture, per cent	15.65	15.50	14.21	16.99	14.88	16.69	18.85	14.21	18.85
Volatile matter, do	36.87	36.94	33.17	33.03	35.35	31.42	35.44		
Fixed carbon, do	35.84	38.37	37.40	35.52	33.73	31.19	35.43		
Ash, do	11.64	9.19	15.22	14.46	16.04	20.70	10.28	15.22	10.28
	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—									
Hydrogen, do			5.50						
Carbon, do			54.08						
Nitrogen, do			1.81						
Oxygen, do			19.23						
Sulphur, do	5.10	5.19	4.66	5.15	4.73	5.50	3.93	4.66	3.93
Ash, do			15.22						
			100.00						
Calorific value determined, calories	5,716		5,566		[d]5,436				
Calorific value determined, B. T. U.	10,289		10,019		[d]9,785				

[a] Represents 10 tons of coal.

[b] Represents 6 tons of coal.

[c] Refuse from boiler test, laboratory No. 1491: Combustible, 18.07 per cent; ash, 81.93 per cent.

[d] Derived from the determinations on the carload sample.

Chemical analyses of Iowa No. 3 coal.

[Lump coal from mine No. 4. Received from Gibson Coal Mining Company, Altoona, Iowa.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 49.[b]	Sample of coal from coke test No. 35, washed coal.	Coke sample, washed coal.[c]	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1312	1313	1434	1392	1389	1399	1484	1389
Loss of moisture on air drying..per cent..	9.60	11.00	9.80	1.50	6.90	4.00	9.80	6.90
Analysis of air-dried sample:								
Proximate—								
Moisture....do....	5.33	5.51	4.52	11.11	10.67	1.80	4.52	10.67
Volatile matter....do....	41.82	42.04	40.96	36.69	42.18	1.95	....	....
Fixed carbon....do....	40.69	38.55	38.99	36.31	38.53	78.64	....	....
Ash....do....	12.16	13.90	15.53	15.89	8.62	17.61	15.53	8.62
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen....do....	....	....	4.93	....	....	....	....	....
Carbon....do....	....	....	60.62	....	....	....	....	....
Nitrogen....do....	....	....	.93	....	....	....	....	....
Oxygen....do....	....	....	11.16	....	....	....	....	....
Sulphur....do....	6.52	7.59	6.83	6.16	4.88	4.76	6.83	4.88
Ash....do....	....	....	15.53	....	....	....	....	....
			100.00					
Calorific value determined.....calories..	6,539	....	6,309	....	....	....	....	....
Calorific value determined.....B. T. U..	11,770	....	11,356	....	....	....	....	....
Calorific value calculated from ultimate analysis.....calories..	....	....	6,271	....	....	....	....	....
Calorific value calculated from ultimate analysis.....B. T. U..	....	....	11,288	....	....	....	....	....
Phosphorus in coke	....	....	....	....	....	.018	....	....
Analysis corrected to sample as received:								
Proximate—								
Moisture....per cent..	14.42	15.90	13.88	12.44	16.83	5.73	13.88	16.83
Volatile matter....do....	37.81	37.42	36.94	36.14	39.27	1.87	....	....
Fixed carbon....do....	36.78	34.81	35.17	35.77	35.87	75.49	....	....
Ash....do....	10.99	12.37	14.01	15.65	8.03	16.91	14.01	8.03
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen....do....	....	....	5.52	....	....	....	....	....
Carbon....do....	....	....	54.68	....	....	....	....	....
Nitrogen....do....	....	....	.84	....	....	....	....	....
Oxygen....do....	....	....	18.80	....	....	....	....	....
Sulphur....do....	5.89	6.76	6.15	6.07	4.55	4.57	6.15	4.55
Ash....do....	....	....	14.01	....	....	....	....	....
			100.00					
Calorific value determined.....calories..	5,911	....	5,691	[d]5,679	....	....	....	....
Calorific value determined.....B. T. U..	10,640	....	10,244	[d]10,222	....	....	....	....

[a] Represents 12 tons of coal.

[b] Refuse from boiler test, laboratory No. 1398: Combustible, 27.11 per cent; ash, 72.89 per cent.

[c] Specific gravity of the coke substance, 1.88; apparent specific gravity of the coke, 0.81; percentage of porosity, 57.

[d] Derived from the determinations on the carload sample.

Chemical analyses of Iowa No. 4 coal.

[Lump coal from mine No. 3. Received from Centerville Block Coal Company, Centerville, Iowa.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 47.[b]	Sample of coal from coke test No. 34, washed coal.	Coke sample, washed coal.[c]	Sample from washery test, unwashed car sample.	Sample of washed coal, from coke ovens.	Sample of briquettes, boiler test No. 66.[d]
Laboratory sample number	1323	1324	1437	1380	1378	1400	1437	1378	1488
Loss of moisture on air drying, per cent	9.40	8.60	4.50	2.00	3.60	11.00	4.50	3.60	3.90
Analysis of air-dried sample:									
Proximate—									
Moisture ....per cent..	8.53	8.25	10.03	11.71	14.81	2.30	10.03	14.81	9.72
Volatile matter........do....	39.12	38.23	37.27	34.79	38.99	2.60			37.98
Fixed carbon..........do....	44.55	41.40	41.22	38.04	38.79	82.14			39.38
Ash......................do....	7.80	12.12	11.48	15.46	7.41	12.96	11.48	7.41	12.92
	100.00	100.00	100.00	100.00	100.00	100.00			100.00
Ultimate—									
Hydrogen ....do....			5.31						5.42
Carbon ....do....			61.25						62.52
Nitrogen ....do....			.94						.78
Oxygen..................do....			16.56						14.31
Sulphur ....do....	4.42	5.21	4.46	5.14	3.70	3.33	4.46	3.70	4.05
Ash......................do....			11.48						12.92
			100.00						100.00
Calorific value determined. calories..	6,708		6,237						6,292
B. T. U..	12,065		11,227						11,326
Calorific value calculated from ultimate analysis... calories..			6,165						6,394
B. T. U..			11,097						11,509
Phosphorus in coke						.013			
Analysis corrected to sample as received:									
Proximate—									
Moisture ....per cent..	17.13	16.14	14.08	13.48	17.88	13.05	14.08	17.88	13.24
Volatile matter........do....	35.44	34.94	35.59	34.09	37.59	2.32			36.50
Fixed carbon..........do....	40.36	37.84	39.37	37.28	37.39	73.10			37.85
Ash......................do....	7.07	11.08	10.96	15.15	7.14	11.53	10.96	7.14	12.41
	100.00	100.00	100.00	100.00	100.00	100.00			100.00
Ultimate—									
Hydrogen ....do....			5.57						5.64
Carbon ....do....			58.49						60.08
Nitrogen ....do....			.90						.75
Oxygen..................do....			19.82						17.22
Sulphur ....do....	4.00	4.76	4.26	5.04	3.57	2.97	4.26	3.57	3.90
Ash......................do....			10.96						12.41
			100.00						100.00
Calorific value determined. calories..	6,073		5,957	[e]5,613					6,047
B. T. U..	10,931		10,723	[e]10,103					10,885

[a] Represents 31 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1381: Combustible, 19.25 per cent; ash, 80.75 per cent.

[c] Specific gravity of the coke substance, 1.82; apparent specific gravity of the coke, 0.81; percentage of porosity, 55.

[d] Refuse from the boiler test of the briquettes, laboratory No. 1486: Combustible, 23.82 per cent; ash, 76.18 per cent.

[e] Derived from the determinations on the carload sample.

Chemical analyses of Iowa No. 5 coal.

[Run-of-mine coal from mine No. 1. Received from Inland Fuel Company, Chariton, Iowa.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 55.[b]	Sample of coal from coke test No. 40, washed coal.	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number		1332	1333	1433	1423	1419	1433	1419
Loss of moisture on air drying	per cent	9.40	7.10	6.80	3.80	6.70	6.80	6.70
Analysis of air-dried sample:								
Proximate—								
Moisture	do	10.25	12.37	9.22	12.69	13.45	9.22	13.45
Volatile matter	do	35.10	36.98	32.71	33.01	33.30		
Fixed carbon	do	46.12	42.95	44.52	40.37	44.75		
Ash	do	8.53	7.70	13.55	13.93	8.50	13.66	8.50
		100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen	do			5.35				
Carbon	do			59.89				
Nitrogen	do			1.22				
Oxygen	do			16.57				
Sulphur	do	2.64	3.34	3.42	3.21	2.44	3.42	2.44
Ash	do			13.55				
				100.00				
Calorific value determined	calories	6,442		6,105				
	B. T. U.	11,596		10,989				
Calorific value calculated from ultimate analysis	calories			6,045				
	B. T. U.			10,881				
Analysis corrected to sample as received:								
Proximate—								
Moisture	per cent	18.69	18.59	15.39	16.01	19.25	15.39	19.25
Volatile matter	do	31.80	34.36	30.49	31.76	31.07		
Fixed carbon	do	41.78	39.90	41.49	38.83	41.75		
Ash	do	7.73	7.15	12.63	13.40	7.93	12.63	7.93
		100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen	do			5.74				
Carbon	do			55.81				
Nitrogen	do			1.14				
Oxygen	do			21.49				
Sulphur	do	2.39	3.10	3.19	3.09	2.28	3.19	2.28
Ash	do			12.63				
				100.00				
Calorific value determined	calories	5,836		5,690	[c] 5,583			
	B. T. U.	10,505		10,242	[c] 10,049			

[a] Represents 7 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1422: Combustible, 15.28 per cent; ash, 84.72 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Kansas No. 2 coal.

[Coal from mine No. [illegible]. Received from Western Coal and Mining Company, Fleming, Kans.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.	Sample from washer test No. [illegible]	Sample from washer test No. [illegible]	Sample from coke test.
Laboratory number		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Loss of moisture on air drying	per cent			[illegible]	[illegible]	[illegible]	[illegible]
Analysis of air-dried sample:							
Proximate—							
Moisture	do			[illegible]	[illegible]	[illegible]	[illegible]
Volatile matter	do			[illegible]	[illegible]	[illegible]	[illegible]
Fixed carbon	do			[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]	[illegible]	[illegible]	[illegible]
				100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do			[illegible]			
Carbon	do			[illegible]			
Nitrogen	do			[illegible]			
Oxygen	do			[illegible]			
Sulphur	do			[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]			
				100.00			
Calorific value determined	calories			[illegible]			
	B. T. U.			[illegible]			
Calorific value calculated from ultimate analysis	calories			[illegible]			
	B. T. U.			[illegible]			
Analyses corrected to sample as received:							
Proximate—							
Moisture	per cent	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Volatile matter	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fixed carbon	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do			[illegible]			
Carbon	do			[illegible]			
Nitrogen	do			[illegible]			
Oxygen	do			[illegible]			
Sulphur	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]			
				100.00			
Calorific value determined	calories	[illegible]		[illegible]	[illegible]	[illegible]	
	B. T. U.	[illegible]		[illegible]	[illegible]	[illegible]	

[illegible]

Chemical analyses of Kansas No. 2 coal.

[Lump, nut, and slack coal from mine No. 11. Received from Western Coal and Mining Company, Yale, Kans.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 13, washed coal.[b]	Sample of coal from coke test No. 2.	Sample from washery test, unwashed car sample.	Sample of washed coal from boiler test.
Laboratory sample number		1017	1019	1122	1123	1087	1122	1123
Loss of moisture on air drying	per cent			2.00	3.60	1.60	2.00	3.60
Analysis of air-dried sample:								
Proximate—								
Moisture	do			2.23	2.30	2.40	2.23	2.30
Volatile matter	do			31.87	35.60	30.95		
Fixed carbon	do			47.63	53.14	46.28		
Ash	do			18.27	8.96	20.87	18.27	8.96
				100.00	100.00	100.00		
Ultimate—								
Hydrogen	do			4.56				
Carbon	do			63.14				
Nitrogen	do			.94				
Oxygen	do			6.69				
Sulphur	do			6.40	3.91	5.68	6.40	3.91
Ash	do			18.27				
				100.00				
Calorific value determined	calories			6,600				
	B. T. U.			11,880				
Calorific value calculated from ultimate analysis	calories			6,528				
	B. T. U.			11,750				
Analysis corrected to sample as received:								
Proximate—								
Moisture	per cent	2.44	2.36	4.18	5.82	3.96	4.18	5.82
Volatile matter	do	35.16	34.62	31.23	34.32	30.46		
Fixed carbon	do	51.80	51.23	46.68	51.22	45.54		
Ash	do	10.60	11.79	17.91	8.64	20.04	17.91	8.64
		100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen	do			4.69				
Carbon	do			61.88				
Nitrogen	do			.92				
Oxygen	do			8.33				
Sulphur	do	5.63	5.88	6.27	3.77	5.59	6.27	3.77
Ash	do			17.91				
				100.00				
Calorific value determined	calories	7,246		6,468	[c]7,310			
	B. T. U.	13,043		11,642	[c]13,158			

[a] Represents two-thirds of carload of coal.

[b] Refuse from the boiler test, laboratory No. 1124: Combustible, 30.62 per cent; ash, 69.38 per cent.

[c] Derived from the determinations on the carload sample.

Chemical analyses of Kansas No. 3 coal.

[Run of mine coal from mine No. [illegible]. Received from Southern Coal and Mercantile Company, Scammon, Kans.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 3.[b]	Sample of coal from coke test.	Sample from boiler test No. 4.[c]
Laboratory sample number		1088	1087	1086	1061	1074	1082
Analysis of coal, sample as received:							
Proximate:							
Moisture	per cent	[illegible]	[illegible]	[illegible]	[illegible]	1.75	2.25
Volatile matter	do	[illegible]	[illegible]	[illegible]	[illegible]	32.95	34.30
Fixed carbon	do	[illegible]	[illegible]	[illegible]	[illegible]	45.39	51.05
Ash	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate:							
Hydrogen	do			[illegible]			
Carbon	do			[illegible]			
Nitrogen	do			[illegible]			
Oxygen	do			[illegible]			
Sulphur	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do			[illegible]			
				100.00			
Calorific value determined:	Calories	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
	B. T. U	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]

[a] [illegible]

[b] [illegible]

[c] [illegible]

[d] [illegible]

[e] [illegible]

Chemical analyses of Kansas No. 4 coal.

[Lump coal. Received from Atchison Coal Mining Company, Atchison, Kans.]

		Car sample[a]	Sample from boiler test No. 58.[b]	Sample of coal from coke test No. 43.	Coke sample.[c]
Laboratory sample number		1473	1440	1443	1455
Loss of moisture on air drying	per cent..	3.50	0.90	2.20	....
Analysis of air-dried sample:					
Proximate—					
Moisture	do....	3.57	4.65	4.53	....
Volatile matter	do....	37.00	36.65	37.82	....
Fixed carbon	do....	46.80	43.99	44.43	....
Ash	do....	12.63	14.71	13.22	....
		100.00	100.00	100.00	
Ultimate—					
Hydrogen	do....	5.04	....	....	....
Carbon	do....	65.02	....	....	....
Nitrogen	do....	1.07	....	....	....
Oxygen	do....	7.91	....	....	....
Sulphur	do....	8.33	8.54	7.35	....
Ash	do....	12.63	....	....	....
		100.00			
Calorific value determined	calories..	6,854	....	....	....
	B. T. U..	12,337	....	....	....
Calorific value calculated from ultimate analysis	calories..	6,839	....	....	....
	B. T. U..	12,310	....	....	....
Analysis corrected to sample as received:					
Proximate—					
Moisture	per cent..	6.95	5.51	6.63	0.52
Volatile matter	do....	35.70	36.82	36.99	1.68
Fixed carbon	do....	45.16	43.59	43.45	79.82
Ash	do....	12.19	14.58	12.93	17.98
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do....	5.25	....	....	....
Carbon	do....	62.74	....	....	....
Nitrogen	do....	1.04	....	....	....
Oxygen	do....	10.74	....	....	....
Sulphur	do....	8.04	8.46	7.19	6.15
Phosphorus in coke	do....	....	....	....	.015
Ash	do....	12.19	....	....	....
		100.00			
Calorific value determined	calories..	6,614	[d]6,507	....	....
	B. T. U..	11,905	[d]11,713	....	....

[a] Represents 10 tons of coal.

[b] Refuse from boiler test, laboratory No. 1439: Combustible, 21.33 per cent; ash, 78.67 per cent.

[c] Specific gravity of the coke substance, 1.92; apparent specific gravity of the coke, 0.97; percentage of porosity, 50.

[d] Derived from the determinations on the carload sample.

Chemical analyses of Kansas No. 5 coal.

[[illegible] and nut coal from mine No. 11. Received from Southwestern Development Company, West Mineral, Kans.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample (second portion).[b]	Sample from boiler test No. 72.[c]	Sample from gas-producer test No. 24.
Laboratory sample number		1411	1413	1567	1606	1524	1601
Loss of moisture on air drying	per cent.	3.20	4.30	2.30	3.70	1.90	3.30
Analysis of air-dried sample							
Proximate—							
Moisture	do.	1.97	1.56	1.84	.93	2.45	1.09
Volatile matter	do.	33.68	33.79	32.40	33.16	33.05	33.06
Fixed carbon	do.	55.15	51.54	54.97	54.16	52.35	54.22
Ash	do.	9.20	13.11	10.79	11.75	12.15	11.63
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.			4.96			
Carbon	do.			71.90			
Nitrogen	do.			1.09			
Oxygen	do.			7.40			
Sulphur	do.	4.48	4.01	3.86	3.53	4.49	3.10
Ash	do.			10.79			
				100.00			
Calorific value determined	calories	7,418		7,333			
	B. T. U.	13,352		13,199			
Calorific value calculated from ultimate analysis	calories			7,288			
	B. T. U.			13,118			
Analysis corrected to sample as received.							
Proximate—							
Moisture	per cent.	5.11	5.79	4.10	4.60	4.31	4.35
Volatile matter	do.	32.60	32.34	31.65	31.94	32.42	31.97
Fixed carbon	do.	53.39	49.32	53.71	52.15	51.36	52.43
Ash	do.	8.90	12.55	10.54	11.31	11.91	11.25
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.			5.10			
Carbon	do.			70.25			
Nitrogen	do.			1.06			
Oxygen	do.			9.28			
Sulphur	do.	4.34	3.84	3.77	3.40	4.40	3.00
Ash	do.			10.54			
				100.00			
Calorific value determined	calories	7,181		7,164		[d]6,986	[d]7,131
	B. T. U.	12,926		12,895		[d]12,575	[d]12,836

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[a] [illegible]

[b] [illegible]

[c] [illegible] test [illegible] laboratory No. 1[illegible]: Combustible 26.0[illegible] per cent; ash 73.9[illegible] per cent.

[d] [illegible] determinations on the carload sample.

Chemical analyses of Kentucky No. 1 coal.

[Run-of-mine coal from Straight Creek mine No. 2. Received from National Coal and Iron Company, Straight Creek, Ky.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample (second portion).[b]	Sample from boiler test No. 60.[c]	Sample of coal from coke test No. 44.	Coke sample.[d]
Laboratory sample number	1321	1322	1474	1522	1444	1448	1458
Loss of moisture on air drying ....per cent..	1.00	0.90	1.20	1.20	1.20	0.70	1.00
Analysis of air-dried sample:							
Proximate—							
Moisture ....do....	1.93	1.93	1.92	1.77	1.71	2.02	.51
Volatile matter ....do....	36.37	37.42	36.56	36.08	36.04	37.48	.84
Fixed carbon ....do....	58.13	57.83	57.08	56.31	56.27	56.57	93.25
Ash ....do....	3.57	2.82	4.44	5.84	5.98	3.93	5.40
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen ....do....			5.36				
Carbon ....do....			78.31				
Nitrogen ....do....			1.85				
Oxygen ....do....			8.80				
Sulphur ....do....	.90	.85	1.24	1.21	1.20	1.24	.87
Ash ....do....			4.44				
			100.00				
Calorific value determined ....calories..	8,037		7,955				
Calorific value determined ....B. T. U..	14,467		14,319				
Calorific value calculated from ultimate analysis ....calories..			7,823				
Calorific value calculated from ultimate analysis ....B. T. U..			14,081				
Phosphorus in coke							.036
Analysis corrected to sample as received:							
Proximate—							
Moisture ....per cent..	2.91	2.81	3.10	2.95	2.89	2.71	1.50
Volatile matter ....do....	36.01	37.08	36.12	35.65	35.61	37.22	.83
Fixed carbon ....do....	57.55	57.31	56.39	55.63	55.59	56.17	92.32
Ash ....do....	3.53	2.80	4.39	5.77	5.91	3.90	5.35
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen ....do....			5.43				
Carbon ....do....			77.37				
Nitrogen ....do....			1.83				
Oxygen ....do....			9.76				
Sulphur ....do....	.89	.84	1.22	1.20	1.19	1.23	.86
Ash ....do....			4.39				
			100.00				
Calorific value determined ....calories..	7,957		7,860		[e] 7,749		
Calorific value determined ....B. T. U..	14,322		14,148		[e] 13,948		

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[a] Represents 23 tons of coal.

[b] Represents 12 tons of coal.

[c] Refuse from the boiler test, laboratory No. 1445: Combustible, 35.80 per cent; ash, 64.20 per cent.

[d] Specific gravity of the coke substance, 1.83; apparent specific gravity of the coke, 0.92; percentage of porosity, 50. [Air-dried sample.]

[e] Derived from the determinations on the carload sample.

Chemical analyses of Kentucky No. 2 coal.

[Lump, nut, pea, and slack coal from mine No. 11. Received from St. Bernard Mining Company, Earlington, Ky.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample (coarse portion of car-load).[a]	Car sample (fine portion of car-load).[b]	Sample from boiler test No. 57.[c]	Sample of coal from coke test No. 42.	Sample of briquettes, boiler test No. 76.[d]
Laboratory sample number	1365	1366	1461	1469	1436	1438	1544
Loss of moisture on air drying ....per cent..	2.90	2.60	2.70	4.20	1.40	2.90	3.30
Analysis of air-dried sample:							
Proximate—							
Moisture ....do....	5.76	5.34	5.36	5.50	6.45	5.93	3.94
Volatile matter ....do....	39.19	38.61	38.99	34.80	38.45	33.42	38.33
Fixed carbon ....do....	47.74	45.56	46.27	41.24	46.40	42.36	45.83
Ash ....do....	7.31	10.49	9.38	18.46	8.70	18.29	11.90
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen ....do....	....	....	5.33	....	....	....	4.76
Carbon ....do....	....	....	67.64	....	....	....	67.23
Nitrogen ....do....	....	....	1.25	....	....	....	1.23
Oxygen ....do....	....	....	12.68	....	....	....	11.04
Sulphur ....do....	3.63	4.31	3.72	4.67	3.42	4.16	3.84
Ash ....do....	....	....	9.38	....	....	....	11.90
			100.00				100.00
Calorific value determined ....calories..	7,063	....	6,966	....	....	....	6,824
B. T. U..	12,713	....	12,539	....	....	....	12,283
Calorific value calculated from ultimate analysis ....calories..	....	....	6,840	....	....	....	6,683
B. T. U..	....	....	12,312	....	....	....	12,029
Analysis corrected to sample as received:							
Proximate—							
Moisture ....per cent..	8.49	7.80	7.91	9.47	7.76	8.66	7.11
Volatile matter ....do....	38.05	37.60	37.94	33.34	37.91	32.45	37.07
Fixed carbon ....do....	46.36	44.38	45.02	39.51	45.75	41.13	44.31
Ash ....do....	7.10	10.22	9.13	17.68	8.58	17.76	11.51
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen ....do....	....	....	5.48	....	....	....	4.96
Carbon ....do....	....	....	65.81	....	....	....	65.01
Nitrogen ....do....	....	....	1.22	....	....	....	1.19
Oxygen ....do....	....	....	14.74	....	....	....	13.62
Sulphur ....do....	3.53	4.20	3.62	4.47	3.37	4.04	3.71
Ash ....do....	....	....	9.13	....	....	....	11.51
			100.00				100.00
Calorific value determined ....calories..	6,858	....	6,778	....	[e] 6,854	....	6,599
B. T. U..	12,344	....	12,200	....	[e] 12,337	....	11,878

[a] Represents 20 tons of coal.

[b] Represents 5 tons of coal.

[c] Refuse from the boiler test, laboratory No. 1435: Combustible, 20.63 per cent; ash, 79.37 per cent.

[d] Refuse from boiler test of the briquettes, laboratory No. 1545: Combustible, 16.55 per cent; ash, 83.45 per cent.

[e] Derived from the determinations on the carload sample.

Chemical analyses of Kentucky No. 3 coal.

[Run-of-mine coal from Barnsley mine. Received from St. Bernard Mining Company, Earlington, Ky.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample of screened coal.[b]	Sample from boiler test No. 64.[c]	Sample from gas-producer test No. 12.	Sample of coal from coke test No. 47, washed coal.	Coke sample from washed coal.[d]	Sample from washery test, unwashed car sample.	Sample of washed coal, sample from coke ovens.
Laboratory sample number	1361	1367	1506	1505	1477	1480	1466	1484	1506	1466
Loss of moisture on air drying, per cent	3.30	2.20	2.20	1.60	1.50	1.10	4.30	....	2.20	4.30
Analysis of air-dried sample:										
Proximate—										
Moisture, per cent	6.00	5.91	5.85	6.34	6.51	6.25	6.49	....	5.85	6.49
Volatile matter, do	37.45	38.39	36.90	37.61	37.89	39.00	39.01	....	....	....
Fixed carbon, do	48.23	46.19	46.96	48.00	45.53	45.66	46.77	....	....	....
Ash, do	8.32	9.51	10.29	8.05	10.07	9.09	7.73	....	10.29	7.73
	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
Ultimate—										
Hydrogen, do	....	....	5.27	....	....	....	....	....	....	....
Carbon, do	....	....	66.75	....	....	....	....	....	....	....
Nitrogen, do	....	....	1.43	....	....	....	....	....	....	....
Oxygen, do	....	....	12.66	....	....	....	....	....	....	....
Sulphur, do	3.07	4.12	3.60	2.99	3.97	3.72	2.61	....	3.60	2.61
Ash, do	....	....	10.29	....	....	....	....	....	....	....
			100.00							
Calorific value determined, calories	....	6,797	6,829	....	....	6,898	....	....	....	....
Calorific value determined, B. T. U	....	12,235	12,292	....	....	12,416	....	....	....	....
Calorific value calculated from ultimate analysis, calories	....	....	6,746	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis, B. T. U	....	....	12,143	....	....	....	....	....	....	....
Analysis corrected to sample as received:										
Proximate—										
Moisture, per cent	9.10	7.98	7.92	7.84	7.92	7.28	10.51	.14	7.92	10.51
Volatile matter, do	36.21	37.55	36.09	37.01	37.32	38.57	37.33	.56	....	....
Fixed carbon, do	46.64	45.17	45.93	47.23	44.84	45.16	44.76	86.31	....	....
Ash, do	8.05	9.30	10.06	7.92	9.92	8.99	7.40	12.99	10.06	7.40
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen, do	....	....	5.39	....	....	....	....	....	....	....
Carbon, do	....	....	65.29	....	....	....	....	....	....	....
Nitrogen, do	....	....	1.40	....	....	....	....	....	....	....
Oxygen, do	....	....	14.34	....	....	....	....	....	....	....
Sulphur, do	2.97	4.03	3.52	2.94	3.91	3.68	2.51	2.16	3.52	2.51
Phosphorus, do	....	....	....	....	....	....	....	.0094	....	....
Sulphur in the ash, do	....	....	10.06	....	....	....	....	.084	....	....
			100.00							
Calorific value determined, calories	....	6,647	6.679	....	[e]6,668	[f]6,824	....	....	....	....
Calorific value determined, B. T. U	....	11,965	12,022	....	[e]12,002	[f]12,283	....	....	....	....

[a] Represents 12 tons of coal.

[b] Represents 17 tons of coal.

[c] Refuse from boiler test, laboratory No. 1478: Combustible, 19.82 per cent; ash, 80.18 per cent.

[d] Specific gravity of the coke substance, 1.81; apparent specific gravity of the coke, 0.80; percentage of porosity, 56.

[e] Derived from the determinations on the carload sample.

[f] Calorific value derived from determinations on the carload sample: 6,814 calories; 12,265 B, T. U.

Chemical analyses of Kentucky No. 4 coal.

[Run-of-mine coal. Received from Wheatcroft Coal and Mining Company, Wheatcroft, Ky.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 62.[b]	Sample of coal from coke test No. 46, washed coal.	Coke sample from washed coal.[c]	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1382	1384	1589	1462	1459	1475	1589	1459
Loss of moisture on air drying..per cent..	2.60	2.00	2.80	3.30	3.10		2.80	3.10
Analysis of air-dried sample:								
Proximate—								
Moisture....do....	2.06	2.82	2.54	2.68	3.18	.52	2.54	3.18
Volatile matter....do....	39.19	40.53	36.08	36.87	40.32	.73		
Fixed carbon....do....	51.15	49.50	46.79	47.30	50.26	86.40		
Ash....do....	7.60	7.15	14.59	13.15	6.24	12.35	14.59	6.24
	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—								
Hydrogen....do....			4.58					
Carbon....do....			66.50					
Nitrogen....do....			1.28					
Oxygen....do....			8.43					
Sulphur....do....	3.42	3.28	4.67	3.85	2.85	2.37	4.67	2.85
Ash....do....			14.59					
			100.00					
Calorific value determined....calories..	7,336		6,830					
Calorific value determined....B. T. U...	13,206		12,294					
Calorific value calculated from ultimate analysis....calories..			6,677					
Calorific value calculated from ultimate analysis....B. T. U...			12,019					
Phosphorus in coke						.015		
Sulphur in the ash....per cent..						.014		
Analysis corrected to sample as received:								
Proximate—								
Moisture....per cent..	4.61	4.76	5.27	5.89	6.18		5.27	6.18
Volatile matter....do....	38.17	39.72	35.07	35.65	39.07			
Fixed carbon....do....	49.82	48.51	45.48	45.74	48.70			
Ash....do....	7.40	7.01	14.18	12.72	6.05		14.18	6.05
	100.00	100.00	100.00	100.00	100.00			
Ultimate—								
Hydrogen....do....			4.71					
Carbon....do....			64.65					
Nitrogen....do....			1.24					
Oxygen....do....			10.68					
Sulphur....do....	3.33	3.21	4.54	3.72	2.76		4.54	2.76
Ash....do....			14.18					
			100.00					
Calorific value determined....calories..	7,145		6,639	[d]6,764				
Calorific value determined....B. T. U...	12,861		11,950	[d]12,175				

[a] Represents 23 tons of coal.

[b] Refuse from boiler test, laboratory No. 1463: Combustible, 24.65 per cent; ash, 75.35 per cent.

[c] Specific gravity of the coke substance, 1.84; apparent specific gravity of the coke, 0.98; percentage of porosity, 49.

[d] Derived from the determinations on the carload sample.

Chemical analyses of Missouri No. 1 coal.

[Run-of-mine coal from New Home mine No. 1. Received from New Home Coal Company, Sprague, Mo.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.	Sample from boiler test No. 12.[a]	Sample from boiler test No. 15, washed coal.[b]	Sample from washery test, coarse coal unwashed.	Sample of washed coal, coarse coal.	Sample of briquettes, boiler test No. 23.[c]
Laboratory sample number	1041	1043	1126	1119	1137	1133	1140	1206
Loss of moisture on air drying..per cent..			5.00	3.20	3.90	4.70	4.40	2.90
Analysis of air-dried sample:								
Proximate—								
Moisture...do...			3.50	4.22	4.20	3.61	4.38	3.58
Volatile matter...do...			35.35	36.03	38.30			38.72
Fixed carbon...do...			40.77	41.99	46.00			43.10
Ash...do...			20.38	17.76	11.50	21.03	13.50	14.60
			100.00	100.00	100.00			100.00
Ultimate—								
Hydrogen...do...			4.64					4.86
Carbon...do...			60.00					66.07
Nitrogen...do...			.99					1.12
Oxygen...do...			8.46					8.66
Sulphur...do...			5.53	4.51	3.73	6.48	3.67	4.69
Ash...do...			20.38					14.60
			100.00					100.00
Calorific value determined...calories..			6,191					6,790
Calorific value determined...B. T. U..			11,144					12,220
Calorific value calculated from ultimate analysis...calories..			6,206					6,748
Calorific value calculated from ultimate analysis...B. T. U..			11,171					12,146
Analysis corrected to sample as received:								
Proximate—								
Moisture...per cent..	4.80	4.92	8.33	7.28	7.93	8.14	8.59	6.38
Volatile matter...do...	38.10	38.28	33.58	34.88	36.81			37.60
Fixed carbon...do...	42.93	42.28	38.73	40.64	44.21			41.85
Ash...do...	14.17	14.52	19.36	17.20	11.05	20.04	12.91	14.17
	100.00	100.00	100.00	100.00	100.00			100.00
Ultimate—								
Hydrogen...do...			4.97					5.04
Carbon...do...			57.00					64.15
Nitrogen...do...			.94					1.09
Oxygen...do...			12.48					10.99
Sulphur...do...	5.35	5.34	5.25	4.37	3.58	6.17	3.51	4.56
Ash...do...			19.36					14.17
			100.00					100.00
Calorific value determined...calories..		6,653	5,881	[d] 6,237	[d] 6,736			6,593
Calorific value determined...B. T. U..		11,975	10,586	[d] 11,227	[d] 12,125			11,867

[a] Refuse from boiler test, laboratory No. 1120: Combustible, 19.85 per cent; ash, 80.15 per cent.

[b] Refuse from boiler test, laboratory No. 1139: Combustible, 13.53 per cent; ash, 86.47 per cent.

[c] Refuse from the boiler test of the briquettes, laboratory No. 1207: Combustible, 16.19 per cent; ash, 83.81 per cent.

[d] Derived from the determinations on the carload sample.

Chemical analyses of Missouri No. 2 coal.

[Run-of-mine coal from mine No. 8. Received from Northwestern Coal and Mining Company, Bevier, Mo.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 37.[b]	Sample from boiler test No. 44.[c]	Sample from gas-producer test No. 70.	Sample of coal from coke test No. 26, washed coal.	Coke sample from washed coal.[d]	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1226	1227	1348	1306	1346	1360	1304	1325	1348	1304
Loss of moisture on air drying, per cent	6.20	5.00	2.60	3.60	2.10	2.80	3.40	1.30	2.60	3.40
Analysis of air-dried sample:										
Proximate—										
Moisture ....per cent	9.10	8.31	9.14	9.86	9.67	9.05	11.12	2.18	9.14	11.12
Volatile matter ....do	41.07	38.47	34.53	34.10	32.43	36.30	36.78	1.82	....	....
Fixed carbon ....do	41.53	42.00	39.02	38.72	40.64	39.38	44.07	81.34	....	....
Ash ....do	8.30	11.22	17.31	17.33	17.26	15.27	8.03	14.66	17.31	8.03
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen ....do	....	....	4.96	....	....	....	....	....	....	....
Carbon ....do	....	....	56.25	....	....	....	....	....	....	....
Nitrogen ....do	....	....	.99	....	....	....	....	....	....	....
Oxygen ....do	....	....	15.19	....	....	....	....	....	....	....
Sulphur ....do	4.04	4.03	5.30	5.10	4.71	4.69	3.37	2.82	5.30	3.37
Ash ....do	....	....	17.31	....	....	....	....	....	....	....
			100.00							
Calorific value determined — calories	6,625	....	5,806	....	....	6,004	....	....	....	....
Calorific value determined — B. T. U.	11,925	....	10,451	....	....	10,807	....	....	....	....
Calorific value calculated from ultimate analysis — calories	....	....	5,719	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis — B. T. U.	....	....	10,294	....	....	....	....	....	....	....
Phosphorus in coke	....	....	....	....	....	....	....	.02	....	....
Analysis corrected to sample as received:										
Proximate—										
Moisture ....per cent	14.74	12.90	11.50	13.09	11.57	11.60	14.14	3.45	11.50	14.14
Volatile matter ....do	38.53	36.54	33.63	32.88	31.75	35.28	35.53	1.80	....	....
Fixed carbon ....do	38.95	39.90	38.01	37.83	39.78	38.28	42.57	80.27	....	....
Ash ....do	7.78	10.66	16.86	16.70	16.90	14.84	7.76	14.48	16.86	7.76
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen ....do	....	....	5.12	....	....	....	....	....	....	....
Carbon ....do	....	....	54.79	....	....	....	....	....	....	....
Nitrogen ....do	....	....	.96	....	....	....	....	....	....	....
Oxygen ....do	....	....	17.11	....	....	....	....	....	....	....
Sulphur ....do	3.79	3.83	5.16	4.92	4.60	4.56	3.26	2.79	5.16	3.26
Ash ....do	....	....	16.86	....	....	....	....	....	....	....
			100.00							
Calorific value determined — calories	6,214	....	5,655	[e]5,551	[e]5,681	[f]5,836	....	....	....	....
Calorific value determined — B. T. U.	11,185	....	10,179	[e]9,992	[e]10,226	[f]10,505	....	....	....	....

[a] Represents 32 tons of coal.

[b] Refuse from the boiler test, laboratory No. 1306: Combustible, 20.20 per cent; ash, 79.80 per cent.

[c] Refuse from boiler test, laboratory No. 1345. Combustible, 19.83 per cent, ash, 80.17 per cent.

[d] Specific gravity of the coke substance 1.86, apparent specific gravity of the coke, 0.90; percentage of porosity, 52.

[e] Derived from the determinations on the carload sample.

[f] Calorific value derived from determinations on the carload sample: 5,849 calories; 10,528 B. T. U.

Chemical analyses of Missouri No. 3 coal.

[Slack coal. Received from Mendota Coal and Mining Company, Mendota, Mo.]

	Car sample.[a]	Sample from boiler test No. 78.[b]	Sample from boiler test No. 77, washed coal.[c]	Sample of coal from coke test No. 56, washed coal.	Sample from washery test, unwashed.	Sample of washed coal.	Sample from washery test, refuse.
Laboratory sample number	1549	1553	1551	1528	1531	1529	1530
Loss of moisture on air drying .... per cent..	10.80	12.40	11.90	12.30	4.60	11.20	17.30
Analysis of air-dried sample:							
Proximate—							
Moisture .... do....	5.51	7.11	10.07	13.51	10.24	14.30	7.35
Volatile matter .... do....	32.08	29.89	35.39	37.74	....	....	....
Fixed carbon .... do....	39.11	34.22	44.98	40.49	....	....	....
Ash .... do....	23.30	28.78	9.56	8.26	29.76	8.55	44.38
	100.00	100.00	100.00	100.00			
Ultimate—							
Hydrogen .... do....	4.52	....	....	....	....	....	....
Carbon .... do....	54.79	....	....	....	....	....	....
Nitrogen .... do....	.92	....	....	....	....	....	....
Oxygen .... do....	12.34	....	....	....	....	....	....
Sulphur .... do....	4.13	4.40	3.25	3.12	4.51	3.26	4.77
Ash .... do....	23.30	....	....	....	....	....	....
	100.00						
Calorific value determined .... calories..	5,506	....	....	....	....	....	....
Calorific value determined .... B. T. U...	9,911	....	....	....	....	....	....
Calorific value calculated from ultimate analysis .... calories..	5,547	....	....	....	....	....	....
Calorific value calculated from ultimate analysis .... B. T. U...	9,985	....	....	....	....	....	....
Analysis corrected to sample as received:							
Proximate—							
Moisture .... Per cent..	15.71	18.63	20.78	24.15	14.37	23.90	23.38
Volatile matter .... do....	28.62	26.18	31.18	33.10	....	....	....
Fixed carbon .... do....	34.89	29.98	39.61	35.51	....	....	....
Ash .... do....	20.78	25.21	8.43	7.24	28.39	7.59	36.70
	100.00	100.00	100.00	100.00			
Ultimate—							
Hydrogen .... do....	5.23	....	....	....	....	....	....
Carbon .... do....	48.87	....	....	....	....	....	....
Nitrogen .... do....	.82	....	....	....	....	....	....
Oxygen .... do....	20.61	....	....	....	....	....	....
Sulphur .... do....	3.69	3.85	2.88	2.74	4.30	2.89	3.94
Ash .... do....	20.78	....	....	....	....	....	....
	100.00						
Calorific value determined .... calories..	4,911	[d]4,310	[d]5,546	....	....	....	....
Calorific value determined .... B. T. U...	8,840	[d]7,758	[d]9,983	....	....	....	....

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[a] Represents 7 tons of coal.
[b] Refuse from the boiler test, laboratory No. 1552: Combustible, 16.08 per cent; ash, 83.92 per cent.
[c] Refuse from the boiler test, laboratory No. 1550: Combustible, 27.54 per cent; ash, 72.46 per cent.
[d] Derived from the determinations on the carload sample.

Chemical analyses of Missouri No. 4 coal.

[Run-of-mine coal. Received from Morgan County Coal Company, Barnett, Mo.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 70.[b]	Sample of coal from coke test No. 54.	Coke sample.[c]
Laboratory sample number		1446	1447	1516	1520	1513	1519
Loss of moisture on air drying	per cent..	7.40	6.00	7.70	7.90	6.50	1.40
Analysis of air-dried sample:							
Proximate—							
Moisture	do....	6.42	4.86	5.39	4.71	5.92	1.13
Volatile matter	do....	40.73	43.74	44.91	43.54	44.23	1.12
Fixed carbon	do....	45.39	44.86	44.47	45.73	44.22	86.79
Ash	do....	7.46	6.54	5.23	6.02	5.63	10.96
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	5.77	....	....	....
Carbon	do....	....	....	72.45	....	....	....
Nitrogen	do....	....	....	.75	....	....	....
Oxygen	do....	....	....	10.25	....	....	....
Sulphur	do....	5.46	5.32	5.55	5.41	5.49	4.67
Ash	do....	....	....	5.23	....	....	....
				100.00			
Calorific value determined	calories..	6,962	....	7,516	....	....	....
	B. T. U...	12,582	....	13,529	....	....	....
Calorific value calculated from ultimate analysis	calories..	....	....	7,526	....	....	....
	B. T. U...	....	....	13,547	....	....	....
Phosphorus in coke		....	....	....	....	....	.018
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent..	13.34	10.57	12.67	12.24	12.04	2.51
Volatile matter	do....	37.72	41.11	41.45	40.10	41.35	1.11
Fixed carbon	do....	42.03	42.17	41.05	42.11	41.34	85.57
Ash	do....	6.91	6.15	4.83	5.55	5.27	10.81
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do....	....	....	6.18	....	....	....
Carbon	do....	....	....	66.87	....	....	....
Nitrogen	do....	....	....	.69	....	....	....
Oxygen	do....	....	....	16.31	....	....	....
Sulphur	do....	5.06	5.00	5.12	4.98	5.14	4.60
Ash	do....	....	....	4.83	....	....	....
				100.00			
Calorific value determined	calories..	6,447	....	6,937	[d]6,922	....	....
	B. T. U...	11,605	....	12,487	[d]12,460	....	....

[a] Represents 10 tons of coal.
[b] Refuse from boiler test, laboratory No. 1527: Combustible, 26.17 per cent; ash, 73.83 per cent.
[c] Specific gravity of the coke substance, 1.83; apparent specific gravity of the coke, 1.15; percentage of porosity, 37.
[d] Derived from the determinations on the carload sample.

Chemical analyses of Montana No. 1 coal.

[Black lignite, washed nut. Received from Northwestern Improvement Co., Red Lodge, Mont.]

		Car sample.[a]	Sample from gas-producer test No. 5.
Laboratory sample number		1298	1300
Loss of moisture on air drying	per cent..	2.20	1.90
Analysis of air-dried sample:			
Proximate—			
Moisture	do....	9.05	9.68
Volatile matter	do....	36.70	35.22
Fixed carbon	do....	43.03	44.15
Ash	do....	11.22	10.95
		100.00	100.00
Ultimate—			
Hydrogen	do....	5.25	....
Carbon	do....	60.41	....
Nitrogen	do....	1.36	....
Oxygen	do....	20.00	....
Sulphur	do....	1.76	1.75
Ash	do....	11.22	....
		100.00	
Calorific value determined	calories..	5,987	6,017
	B. T. U..	10,777	10,831
Calorific value calculated from ultimate analysis	calories..	5,868	....
	B. T. U..	10,562	....
Analysis corrected to sample as received:			
Proximate—			
Moisture	per cent..	11.05	11.40
Volatile matter	do....	35.90	34.55
Fixed carbon	do....	42.08	43.31
Ash	do....	10.97	10.74
		100.00	100.00
Ultimate—			
Hydrogen	do....	5.37	....
Carbon	do....	59.08	....
Nitrogen	do....	1.33	....
Oxygen	do....	21.52	....
Sulphur	do....	1.73	1.72
Ash	do....	10.97	....
		100.00	
Calorific value determined	calories..	5,855	[b]5,903
	B. T. U..	10,539	[b]10,625

[a] Represents 21 tons of coal.

[b] Calorific value derived from determinations on the carload sample: 5,847 calories; 10,525 B. T. U.

Chemical analyses of New Mexico No. 1 coal.

[Lump and slack coal. Received from American Fuel Company mines near Gallup, N. Mex.]

		Mine sample A.	Mine sample B.	Mine sample C.	Mine sample D.	Car sample No. 1.[a]	Car sample No. 2.[b]	Sample from boiler test No. 27.[c]
Laboratory sample number		1023	1024	1025	1026	1278	1278A	1232
Loss of moisture on air drying	per cent					1.60	6.40	0.70
Analysis of air-dried sample:								
Proximate—								
Moisture	do					10.86	8.17	11.28
Volatile matter	do					35.14		38.12
Fixed carbon	do					46.90		41.87
Ash	do					7.10		8.73
						100.00		100.00
Ultimate—								
Hydrogen	do					5.78		
Carbon	do					64.34		
Nitrogen	do					1.06		
Oxygen	do					21.14		
Sulphur	do					.64		.56
Ash	do					7.10	9.86	
						100.00		
Calorific value determined	calories					6,353		
	B. T. U.					11,435		
Calorific value calculated from ultimate analysis	calories					6,277		
	B. T. U.					11,299		
Analysis corrected to sample as received:								
Proximate—								
Moisture	per cent	11.38	12.17	10.92	11.00	12.29	14.06	11.90
Volatile matter	do	42.02	41.68	42.63	42.63	34.58		37.85
Fixed carbon	do	43.13	43.09	42.35	42.44	46.14		41.57
Ash	do	3.47	3.06	4.10	3.93	6.99		8.68
		100.00	100.00	100.00	100.00	100.00		100.00
Ultimate—								
Hydrogen	do					5.82		
Carbon	do					63.31		
Nitrogen	do					1.08		
Oxygen	do					22.22		
Sulphur	do	.55	.53	.48	.56	.63		.56
Ash	do					6.99	9.23	
						100.00		
Calorific value determined	calories				6,603	6,251		
	B. T. U.				11,885	11,252		

[a] Represents 15 tons of coal.
[b] Represents 11 tons of coal.
[c] Refuse from boiler test, laboratory No. 1231: Combustible, 42.98 per cent; ash, 57.02 per cent.

Chemical analyses of New Mexico No. 2 coal.

[Slack coal from Otero mine, 2 miles from Gallup, N. Mex. Received from Caledonia Coal Company.]

		Mine sample No. 1.	Mine sample No. 2.	Mine sample C.	Mine sample D.	Car sample.[a]	Sample from boiler test No. 26.[b]	Sample of briquettes, boiler test No. 30.[c]
Laboratory sample number		1027	1028	1029	1038	1307	1229	1263
Loss of moisture on air drying	per cent..					2.90	1.20	1.00
Analysis of air-dried sample:								
Proximate—								
Moisture	do....					8.13	8.83	5.81
Volatile matter	do....					34.82	37.76	37.94
Fixed carbon	do....					37.83	36.54	39.47
Ash	do....					19.22	16.87	16.78
						100.00	100.00	100.00
Ultimate—								
Hydrogen	do....					5.05		5.28
Carbon	do....					56.71		62.86
Nitrogen	do....					.98		.80
Oxygen	do....					16.74		12.66
Sulphur	do....					1.30	1.14	1.62
Ash	do....					19.22		16.78
						100.00		100.00
Calorific value determined	calories..					5,668		6,404
	B. T. U..					10,202		11,527
Calorific value calculated from ultimate analysis	calories..					5,631		6,391
	B. T. U..					10,136		11,504
Analysis corrected to sample as received:								
Proximate—								
Moisture	per cent..	9.18	9.68	9.40	10.80	10.79	9.92	6.75
Volatile matter	do....	40.77	41.42	40.05	40.35	33.82	37.30	37.56
Fixed carbon	do....	40.23	40.82	37.87	42.77	36.73	36.11	39.08
Ash	do....	9.87	8.08	12.68	6.08	18.66	16.67	16.61
		100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—								
Hydrogen	do....					5.22	1.13	5.34
Carbon	do....					55.07		62.23
Nitrogen	do....					.95		.79
Oxygen	do....					18.84		13.43
Sulphur	do....	1.27	1.55	.84	1.06	1.26		1.60
Ash	do....					18.66		16.61
						100.00		100.00
Calorific value determined	calories..		6,457			5,504		6,340
	B. T. U..		11,623			9,907		11,412

[a] Represents 20 tons of coal.
[b] Refuse from boiler test, laboratory No. 1228: Combustible, 25.39 per cent; ash, 74.61 per cent.
[c] Refuse from boiler test of briquettes, laboratory No. 1264: Combustible, 28.79 per cent; ash, 71.21 per cent.

Chemical analyses of North Dakota No. 2 coal.

[Run-of-mine brown lignite. Received from [illegible] cars.]

		Car sample.	Sample from boiler test No. [illegible] [a]	Mine sample No. [illegible] [b]	Mine sample No. 2 [b]
Laboratory sample number		[illegible]	[illegible]	[illegible]	[illegible]
Loss of moisture on air drying	per cent	[illegible]	22.11	[illegible]	[illegible]
Analysis of air-dried sample:					
Proximate—					
Moisture	do	[illegible]	[illegible]	[illegible]	[illegible]
Volatile matter	do	[illegible]	[illegible]	[illegible]	[illegible]
Fixed carbon	do	[illegible]	[illegible]	[illegible]	[illegible]
Ash	do	12.26	[illegible]	[illegible]	9.71
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do	[illegible]			
Carbon	do	[illegible]			
Nitrogen	do	[illegible]			
Oxygen	do	[illegible]			
Sulphur	do	2.02	2.15	1.76	1.46
Ash	do	12.26			
		100.00			
Calorific value determined	calories	5,034		5,312	
	B. T. U.	9,061		9,562	
Calorific value calculated from ultimate analysis	calories	[illegible]			
	B. T. U.	[illegible]			
Analysis corrected to sample as received:					
Proximate—					
Moisture	per cent	35.80	35.84	42.06	42.81
Volatile matter	do	29.59	26.13	24.55	26.84
Fixed carbon	do	25.06	27.40	25.73	23.93
Ash	do	9.55	10.63	7.66	6.42
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do	6.61			
Carbon	do	40.03			
Nitrogen	do	.54			
Oxygen	do	41.72			
Sulphur	do	1.55	1.06	1.13	.96
Ash	do	9.55			
		100.00			
Calorific value determined	calories	3,846		3,421	
	B. T. U.	6,923		6,158	

[a] Refuse from boiler test, laboratory No. 1282: Combustible, 41.87 per cent; ash, 58.13 per cent.

[b] Samples obtained by Mr. M. R. Campbell during the field season of 1905.

Chemical analyses of North Dakota No. 2 coal.

[Brown lignite. Received from Cedar Coulee Coal Company, Williston, N. Dak.]

		Mine sample No. 1.	Car sample.	Sample from gas-producer test No. 10.
Laboratory sample number		1730	1416	1430
Loss of moisture on air drying	per cent..	33.10	24.10	27.90
Analysis of air-dried sample:				
Proximate—				
Moisture	do....	12.01	16.70	16.17
Volatile matter	do....	40.62	37.10	38.53
Fixed carbon	do....	39.36	39.49	36.48
Ash	do....	8.01	6.71	8.82
		100.00	100.00	100.00
Ultimate—				
Hydrogen	do....	....	5.61	....
Carbon	do....	....	55.16	....
Nitrogen	do....	....	.91	....
Oxygen	do....	....	30.98	....
Sulphur	do....	1.08	.63	1.29
Ash	do....	....	6.71	....
			100.00	
Calorific value determined	calories..	5,385	5,273	5,242
	B. T. U..	9,693	9,491	9,436
Calorific value calculated from ultimate analysis	calories..	....	5,071	....
	B. T. U..	....	9,128	....
Analysis corrected to sample as received:				
Proximate—				
Moisture	per cent..	41.13	36.78	39.56
Volatile matter	do....	27.17	28.16	27.78
Fixed carbon	do....	26.34	29.97	26.30
Ash	do....	5.36	5.09	6.36
		100.00	100.00	100.00
Ultimate—				
Hydrogen	do....	....	6.93	....
Carbon	do....	....	41.87	....
Nitrogen	do....	....	.69	....
Oxygen	do....	....	44.94	....
Sulphur	do....	.72	.48	.93
Ash	do....	....	5.09	....
			100.00	
Calorific value determined	calories..	3,603	4,002	[b] 3,779
	B. T. U..	6,485	7,204	[b] 6,802

[a] Derived from the determinations on carload sample.
[b] Calorific value derived from determinations on the carload sample: 3,701 calories; 6,662 B. T. U.

Chemical analyses of Pennsylvania No. [illegible] coal.

[Run-of-mine bituminous. Received from Eureka mine No. [illegible], Berwind-White Coal Mining Company, Windber, Pa.]

		Sample from boiler test No. [illegible][a]
Laboratory sample number		[illegible]
Analysis, corrected to sample as received:		
Proximate—		
Moisture	per cent.	[illegible]
Volatile matter	do.	[illegible]
Fixed carbon	do.	[illegible]
Ash	do.	[illegible]
		100.00
Ultimate—		
Hydrogen	do.	[illegible]
Carbon	do.	[illegible]
Nitrogen	do.	[illegible]
Oxygen	do.	[illegible]
Sulphur	do.	[illegible]
Ash	do.	[illegible]
		100.00
Calorific value determined	calories.	[illegible]
	B. T. U.	[illegible]

[a] Refuse from boiler test, laboratory No. [illegible]. Combustible [illegible] per cent; ash [illegible] per cent.

Chemical analyses of Pennsylvania No. [illegible] coal.

[Run-of-mine bituminous. Received from Eureka mine No. [illegible], Berwind-White Coal Mining Company, Windber, Pa.]

		Sample from boiler test No. [illegible][a]
Laboratory sample number		[illegible]
Analysis, corrected to sample as received:		
Proximate—		
Moisture	per cent.	[illegible]
Volatile matter	do.	[illegible]
Fixed carbon	do.	[illegible]
Ash	do.	[illegible]
		100.00
Ultimate—		
Hydrogen	do.	[illegible]
Carbon	do.	[illegible]
Nitrogen	do.	[illegible]
Oxygen	do.	[illegible]
Sulphur	do.	[illegible]
Ash	do.	[illegible]
		100.00
Calorific value determined	calories.	[illegible]
	B. T. U.	[illegible]

[a] Refuse from boiler test, laboratory No. [illegible]. Combustible [illegible] per cent; ash [illegible] per cent.

Chemical analyses of Pennsylvania No. 3 coal.

[Anthracite culm. Received from Pennsylvania Coal Company, Scranton, Pa.]

		Car sample.	Sample of briquettes, boiler test No. 36.[a]
Laboratory sample number		1245	1294
Loss of moisture on air drying	per cent..	3.40	0.10
Analysis of air-dried sample:			
Proximate—			
Moisture	do....	2.08	2.90
Volatile matter	do....	7.27	27.65
Fixed carbon	do....	74.32	55.06
Ash	do....	16.33	14.39
		100.00	100.00
Ultimate—			
Hydrogen	do....	2.81	4.61
Carbon	do....	75.21	71.93
Nitrogen	do....	.80	1.05
Oxygen	do....	4.08	6.89
Sulphur	do....	.77	1.13
Ash	do....	16.33	14.39
		100.00	100.00
Calorific value determined	calories..	6,929	7,170
	B. T. U..	12,472	12,906
Calorific value calculated from ultimate analysis	calories..	6,886	7,129
	B. T. U..	12,395	12,832
Analysis corrected to sample as received:			
Proximate—			
Moisture	per cent..	5.41	3.00
Volatile matter	do....	7.02	27.62
Fixed carbon	do....	71.79	55.00
Ash	do....	15.78	14.38
		100.00	100.00
Ultimate—			
Hydrogen	do....	3.10	4.62
Carbon	do....	72.65	71.86
Nitrogen	do....	.77	1.05
Oxygen	do....	6.96	6.96
Sulphur	do....	.74	1.13
Ash	do....	15.78	14.38
		100.00	100.00
Calorific value determined	calories..	6,693	7,163
	B. T. U..	12,047	12,893

[a] Briquettes made with mixture of Pennsylvania anthracite culm and West Virginia No. 1 bituminous. Refuse from boiler test of briquette, laboratory No. 1296: Combustible, 36.12 per cent; ash, 63.88 per cent.

Chemical analyses of Texas No. 1 coal.

[Brown lignite. Received from Houston County Coal and Manufacturing Company, 11 miles south of Crockett, Tex.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from gas-producer test No. 11.
Laboratory sample number		1195	1196	1456	1460
Loss of moisture on air drying	per cent..	14.40	16.30	24.60	20.00
Analysis of air-dried sample.					
Proximate—					
Moisture	do....	21.25	20.55	13.40	16.88
Volatile matter	do....	43.25	47.20	42.75	40.42
Fixed carbon	do....	22.85	19.41	29.00	29.75
Ash	do....	12.65	12.84	14.85	12.95
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do....			5.57	
Carbon	do....			52.06	
Nitrogen	do....			.95	
Oxygen	do....			25.53	
Sulphur	do....	.65	.67	1.04	.79
Ash	do....			14.85	
				100.00	
Calorific value determined	calories..		4,741	5,199	5,046
	B. T. U..		8,534	9,358	9,083
Calorific value calculated from ultimate analysis	calories..			5,046	
	B. T. U..			9,083	
Analysis corrected to sample as received:					
Proximate—					
Moisture	per cent..	32.58	33.50	34.70	33.50
Volatile matter	do....	37.02	39.50	32.23	32.34
Fixed carbon	do....	19.56	16.25	21.87	23.80
Ash	do....	10.84	10.75	11.20	10.36
		100.00	100.00	100.00	100.00
Ultimate—					
Hydrogen	do....			6.93	
Carbon	do....			39.25	
Nitrogen	do....			.72	
Oxygen	do....			41.12	
Sulphur	do....	.56	.56	.78	.63
Ash	do....			11.20	
				100.00	
Calorific value determined	calories..		3,968	3,920	[b]4,037
	B. T. U..		7,142	7,056	[b]7,267

[a] Represents 21 tons of coal.

[b] Calorific value derived from determinations on the carload sample 4,076 calories, 7,337 B. T. U.

Chemical analyses of Texas No. 2 coal.

[Brown lignite. Received from Consumers' Lignite Company, Hoyt, Tex.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from gas-producer test No. 18.
Laboratory sample number	1241	1243	1610	1597
Loss of moisture on air drying ... per cent	5.80	5.90	25.80	25.80
Analysis of air-dried sample:				
Proximate—				
Moisture ... do	24.48	27.04	11.02	10.66
Volatile matter ... do	38.17	43.76	41.79	39.42
Fixed carbon ... do	28.94	20.17	36.84	40.11
Ash ... do	8.41	9.03	10.35	9.81
	100.00	100.00	100.00	100.00
Ultimate—				
Hydrogen ... do				5.28
Carbon ... do				57.31
Nitrogen ... do				1.06
Oxygen ... do				25.83
Sulphur ... do	.53	.61	.75	.71
Ash ... do				9.81
				100.00
Calorific value determined ... calories	4,716			5,502
Calorific value determined ... B. T. U.	8,489			9,904
Calorific value calculated from ultimate analysis ... calories				5,352
Calorific value calculated from ultimate analysis ... B. T. U.				9,634
Phosphorus in coke				
Analysis corrected to sample as received:				
Proximate—				
Moisture ... per cent	28.86	31.34	33.98	33.71
Volatile matter ... do	35.96	41.18	31.01	29.25
Fixed carbon ... do	27.26	18.98	27.33	29.76
Ash ... do	7.92	8.50	7.68	7.28
	100.00	100.00	100.00	100.00
Ultimate—				
Hydrogen ... do				6.79
Carbon ... do				42.52
Nitrogen ... do				.79
Oxygen ... do				42.09
Sulphur ... do	.50	.57	.56	.53
Ash ... do				7.28
				100.00
Calorific value determined ... calories	4,442			4,082
Calorific value determined ... B. T. U.	7,996			7,348

[a] Represents 15 tons of coal.

Chemical analyses of West Virginia No. 1 coal.

[illegible] Received from Virginia and Pittsburg Coal Company, Kingmont, W. Va.]

[illegible]

Chemical analyses of West Virginia No. 2 coal.

[Run-of-mine bituminous coal. Received from Pitcairn mine, Pitcairn Coal Company, Clarksburg, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 25.[b]	Sample of coal from coke test No. 15.	Sample of coal from coke test No. 16, washed coal.	Coke sample, test No. 15.[c]	Coke sample, test No. 16, from washed coal.[d]	Sample from washery test, unwashed car sample.	Sample of washed coal from coke ovens.
Laboratory sample number	1103	1104	1308	1222	1218	1217	1246	1247	1308	1217
Loss of moisture on air drying, per cent	0.90	0.80	0.50	0.20	0.30	2.50	....	....	0.50	2.50
Analysis of air-dried sample:										
Proximate—										
Moisture per cent	1.09	1.08	1.46	1.81	1.43	1.52	0.42	0.59	1.46	1.52
Volatile matter do	40.91	40.62	40.14	39.31	39.32	40.78	.68	1.31	....	....
Fixed carbon do	48.84	50.13	50.50	48.90	51.00	50.47	83.95	86.70	....	....
Ash do	9.16	8.17	7.90	9.98	8.25	7.23	14.95	11.40	7.90	7.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen do	....	....	5.09	....	....	....	....	....	....	....
Carbon do	....	....	74.44	....	....	....	....	....	....	....
Nitrogen do	....	....	1.37	....	....	....	....	....	....	....
Oxygen do	....	....	7.70	....	....	....	....	....	....	....
Sulphur do	4.24	3.78	3.50	2.71	3.39	2.91	3.40	2.24	3.50	2.91
Ash do	....	....	7.90	....	....	....	....	....	....	....
			100.00							
Calorific value determined: calories	7,549	....	7,700	....	....	....	....	....	....	....
Calorific value determined: B. T. U.	13,588	....	13,860	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis: calories	....	....	7,517	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis: B. T. U.	....	....	13,531	....	....	....	....	....	....	....
Phosphorus in coke	....	....	....	....	....	....	.023	.017	....	....
Analysis corrected to sample as received:										
Proximate—										
Moisture per cent	1.98	1.87	1.95	2.01	1.73	3.98	....	....	1.95	3.98
Volatile matter do	40.54	40.30	39.94	39.23	39.20	39.76	....	....	....	....
Fixed carbon do	48.40	49.73	50.25	48.80	50.85	49.21	....	....	....	....
Ash do	9.08	8.10	7.86	9.96	8.22	7.05	....	....	7.86	7.05
	100.00	100.00	100.00	100.00	100.00	100.00				
Ultimate—										
Hydrogen do	....	....	5.13	....	....	....	....	....	....	....
Carbon do	....	....	74.07	....	....	....	....	....	....	....
Nitrogen do	....	....	1.36	....	....	....	....	....	....	....
Oxygen do	....	....	8.10	....	....	....	....	....	....	....
Sulphur do	4.20	3.75	3.48	2.71	3.38	2.84	....	....	3.48	2.84
Ash do	....	....	7.86	....	....	....	....	....	....	....
			100.00							
Calorific value determined: calories	7,481	....	7,661	....	....	....	....	....	....	....
Calorific value determined: B. T. U.	13,466	....	13,790	....	....	....	....	....	....	....

[a] Represents 11 tons of coal.
[b] Refuse from boiler test, laboratory No. 1221: Combustible, 30.94 per cent; ash, 69.06 per cent.
[c] Specific gravity of the coke substance, 1.94; apparent specific gravity of the coke, 1.01; percentage of porosity, 48.
[d] Specific gravity of the coke substance, 1.89; apparent specific gravity of the coke, 1.14; percentage of porosity, 40.

Chemical analyses of West Virginia No. 3 coal.

[Run-of-mine bituminous. Received from West Virginia Coal Company, Richard, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample represents entire car.	Sample from boiler test No. 28.[a]	Sample of coal from coke test No. 17, unwashed coal.	Sample of coal from coke test No. 18, washed coal.	Coke sample from unwashed coal test No. 17.[b]	Coke sample from washed coal test No. 18.[c]	Sample from washery test, unwashed.	Sample of washed coal.
Laboratory sample number	1108	1109	1252	1250	1230	1249	1254	1259	1252	1249
Loss of moisture on air drying, per cent	1.50	0.80	1.30	1.40	0.90	3.00	....	....	....	....
Analysis of air-dried sample:										
Proximate—										
Moisture..........per cent	1.42	1.42	1.00	1.16	1.36	1.14	0.22	0.38	1.00	1.14
Volatile matter.......do	29.08	29.68	30.25	30.74	30.88	30.46	.83	.87	....	....
Fixed carbon.........do	61.19	60.51	58.38	56.90	57.92	59.11	80.81	84.48	....	....
Ash..................do	8.31	8.39	10.37	11.20	9.84	9.29	18.14	14.27	10.37	9.29
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—										
Hydrogen.............do	....	....	4.91	....	....	....	....	....	....	....
Carbon...............do	....	....	76.12	....	....	....	....	....	....	....
Nitrogen.............do	....	....	1.44	....	....	....	....	....	....	....
Oxygen...............do	....	....	6.09	....	....	....	....	....	....	....
Sulphur..............do	.77	.81	1.07	1.38	1.00	1.22	.93	1.19	1.07	1.22
Ash..................do	....	....	10.37	....	....	....	....	....	....	....
			100.00							
Calorific value determined — calories	7,863	....	7,631	....	....	....	....	....	....	....
Calorific value determined — B. T. U	14,158	....	13,736	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis — calories	....	....	7,605	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis — B. T. U	....	....	13,689	....	....	....	....	....	....	....
Phosphorus in coke	....	....	....	....	....	....	.065	.079	....	....
Analysis corrected to sample as received:										
Proximate—										
Moisture..........per cent	2.90	2.21	2.29	2.54	2.25	4.11	....	....	2.29	4.11
Volatile matter.......do	28.64	29.44	29.86	30.31	30.60	29.54	....	....	....	....
Fixed carbon.........do	60.27	60.03	57.62	56.11	57.40	57.34	....	....	....	....
Ash..................do	8.19	8.32	10.23	11.04	9.75	9.01	....	....	10.23	9.01
	100.00	100.00	100.00	100.00	100.00	100.00				
Ultimate—										
Hydrogen.............do	....	....	4.99	....	....	....	....	....	....	....
Carbon...............do	....	....	75.13	....	....	....	....	....	....	....
Nitrogen.............do	....	....	1.42	....	....	....	....	....	....	....
Oxygen...............do	....	....	7.17	....	....	....	....	....	....	....
Sulphur..............do	.75	.80	1.06	1.36	.99	1.18	....	....	1.06	1.18
Ash..................do	....	....	10.23	....	....	....	....	....	....	....
			100.00							
Calorific value determined — calories	7,745	....	7,532	....	....	....	....	....	....	....
Calorific value determined — B. T. U	13,941	....	13,558	....	....	....	....	....	....	....

[a] Refuse from boiler test, laboratory No. 1251: Combustible, 23.83 per cent; ash, 76.17 per cent.
[b] Specific gravity of coke substance, 1.95; apparent specific gravity of coke, 1.06; percentage of porosity, 46.
[c] Specific gravity of coke substance, 1.91; apparent specific gravity of coke, 0.98; percentage of porosity, 50.

Chemical analyses of West Virginia No. 4 coal.

[Run-of-mine bituminous. Received from West Virginia Coal Company, Bretz, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 31.[b]	Sample from gas-producer test No. 4.	Sample of coal from coke test No. 19, unwashed coal.	Sample of coal from coke test No. 20, washed coal.	Coke sample from unwashed coal, test No. 19.[c]	Coke sample from washed coal, test No. 20.[d]	Sample from washery test, unwashed.	Sample of washed coal from coke ovens.
Laboratory sample number.....	1116	1117	1262	1268	1280	1253	1260	1265	1273	1262	1260
Loss of moisture on air drying, per cent........................	1.10	1.20	0.50	1.30	0.90	1.90	2.30	....	....	0.50	2.30
Analysis of air-dried sample:											
Proximate—											
Moisture......per cent..	1.17	1.07	.98	1.24	1.10	.84	1.20	.62	.20	.98	1.20
Volatile matter...do....	29.03	28.88	28.72	28.01	29.15	28.16	28.60	1.43	1.15	....	....
Fixed carbon.....do....	61.97	61.37	61.87	60.63	60.85	60.30	62.49	86.10	85.42	....	....
Ash...............do....	7.83	8.68	8.43	10.12	8.90	10.70	7.71	11.85	13.23	8.43	7.71
	100.00	100.00	100.00	100 00	100.00	100.00	100.00	100.00	100.00		
Ultimate—											
Hydrogen ....do....	....	....	4.85	....	....	....	....	....	....	....	....
Carbon ....do....	....	....	78.21	....	....	....	....	....	....	....	....
Nitrogen ....do....	....	....	1.50	....	....	....	....	....	....	....	....
Oxygen ....do....	....	....	6.11	....	....	....	....	....	....	....	....
Sulphur ....do....	.86	1.28	.90	.97	.80	.88	.79	.82	.69	.90	.79
Ash...............do....	....	....	8.43	....	....	....	....	....	....	....	....
			100.00								
Calorific value determined..............calories..	7,863	....	7,855	....	7,802	....	....	....	....	....	....
Calorific value determined..............B. T. U..	14,153	....	14,139	....	14,044	....	....	....	....	....	....
Calorific value calculated from ultimate analysis............calories..	....	....	7,750	....	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis............B. T. U..	....	....	13,950	....	....	....	....	....	....	....	....
Phosphorus in coke............	....	....	....	....	....	....	....	.031	.019	....	....
Analysis corrected to sample as received:											
Proximate—											
Moisture......per cent..	2.26	2.26	1.48	2.53	1.99	2.72	3.47	....	....	1.48	3.47
Volatile matter...do....	28.71	28.53	28.58	27.64	28.89	27.62	27.95	....	....	....	....
Fixed carbon.....do....	61.29	60.63	61.55	59.84	60.30	59.16	61.05	....	....	....	....
Ash...............do....	7.74	8.58	8.39	9.99	8.82	10.50	7.53	....	....	8.39	7.53
	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
Ultimate—											
Hydrogen ....do....	....	....	4.89	....	....	....	....	....	....	....	....
Carbon ....do....	....	....	77.82	....	....	....	....	....	....	....	....
Nitrogen ....do....	....	....	1.48	....	....	....	....	....	....	....	....
Oxygen ....do....	....	....	6.52	....	....	....	....	....	....	....	....
Sulphur ....do....	.85	1.26	.90	.96	.79	.86	.77	....	....	.90	.77
Ash...............do....	....	....	8.39	....	....	....	....	....	....	....	....
			100.00								
Calorific value determined..............calories..	7,777	....	7,816	....	[e]7,732	....	....	....	....	....	....
Calorific value determined..............B. T. U..	13,999	....	14,069	....	[e]13,918	....	....	....	....	....	....

[a] Represents 25 tons of coal.

[b] Refuse from boiler test, laboratory No. 1269: Combustible, 28.24 per cent; ash, 71.76 per cent.

[c] Specific gravity of coke substance, 1.84; apparent specific gravity of coke, 1.00; percentage of porosity, 47.

[d] Specific gravity of coke substance, 1.94, apparent specific gravity of coke, 0.90; percentage of porosity, 54.

[e] Calorific value derived from determinations on the carload sample: 7,743 calories; 13,937 B. T. U.

Chemical analyses of West Virginia No. 5 coal.

[Lump and nut bituminous coal. Received from Davis Colliery Company, Coalton, W. Va.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 34.[b]	Sample of coal from coke test No. 23, unwashed coal.	Sample of coal from coke test No. 24, washed coal.
Laboratory sample number		1144	1147	1297	1284	1283	1287
Loss of moisture on air drying	per cent	1.80	2.30	0.80	1.30	1.60	3.40
Analysis of air-dried sample:							
Proximate:							
Moisture	do	1.04	.80	.65	.82	.84	1.49
Volatile matter	do	30.16	29.45	29.20	29.33	28.76	29.11
Fixed carbon	do	58.16	59.24	59.97	59.44	59.51	58.76
Ash	do	10.64	10.51	10.18	10.41	10.89	10.64
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate:							
Hydrogen	do			4.78			
Carbon	do			76.36			
Nitrogen	do			1.48			
Oxygen	do			6.21			
Sulphur	do	1.02	1.15	.99	1.02	.91	.94
Ash	do			10.18			
				100.00			
Calorific value determined	calories	7,623		7,682			
	B. T. U.	13,721		13,828			
Calorific value calculated from ultimate analysis	calories			7,572			
	B. T. U.			13,630			
Analysis corrected to sample as received:							
Proximate:							
Moisture	per cent	2.82	3.08	1.45	2.11	2.43	4.84
Volatile matter	do	29.62	28.77	28.97	28.95	28.30	28.12
Fixed carbon	do	57.11	57.88	59.48	58.66	58.55	56.76
Ash	do	10.45	10.27	10.10	10.28	10.72	10.28
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate:							
Hydrogen	do			4.83			
Carbon	do			75.75			
Nitrogen	do			1.47			
Oxygen	do			6.87			
Sulphur	do	1.00	1.13	.98	1.01	.90	.91
Ash	do			10.10			
				100.00			
Calorific value determined	calories	7,486		7,621			
	B. T. U.	13,474		13,717			

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[a] Represents 27 tons of coal.

[b] Refuse from boiler test, laboratory No. 1285. Combustible, 26.02 per cent; ash, 73.98 per cent.

Chemical analyses of West Virginia No. 5 coal—Continued.

[Lump and nut bituminous coal. Received from Davis Colliery Company, Coalton, W. Va.]

	Sample of coal from coke test No. 25, washed coal.	Coke sample, test No. 23, unwashed coal.[a]	Coke sample, test No. 24.[b]	Coke sample, test No. 25.[c]	Sample from washery test, unwashed.	Sample of washed coal.
Laboratory sample number	1301	1302	1303	1317	1297	1301
Loss of moisture on air drying ... per cent	18.60	2.10			0.80	18.60
Analysis of air-dried sample:						
Proximate—						
Moisture ... do	1.10	.51	0.42	0.27	.65	1.10
Volatile matter ... do	29.20	1.14	.43	.78		
Fixed carbon ... do	59.65	78.81	84.34	82.97		
Ash ... do	10.05	19.54	14.81	15.98	10.18	10.05
	100.00	100.00	100.00	100.00		
Ultimate—						
Hydrogen ... do						
Carbon ... do						
Nitrogen ... do						
Oxygen ... do						
Sulphur ... do	.96	.79	.83	.82	.99	.96
Ash ... do						
Calorific value determined ... calories						
Calorific value determined ... B. T. U.						
Calorific value calculated from ultimate analysis ... calories						
Calorific value calculated from ultimate analysis ... B. T. U.						
Phosphorus in coke		.067	.086	.087		
Sulphur in ash		.053	.08	.036		
Analysis corrected to sample as received:						
Proximate—						
Moisture ... per cent	19.50	2.60			1.45	19.50
Volatile matter ... do	23.76	1.12				
Fixed carbon ... do	48.55	77.14				
Ash ... do	8.19	19.14			10.10	8.19
		100.00				
Ultimate—						
Hydrogen ... do						
Carbon ... do						
Nitrogen ... do						
Oxygen ... do						
Sulphur ... do	.79	.77			.98	.79
Ash ... do						
Calorific value determined ... calories						
Calorific value determined ... B. T. U.						

[a] Specific gravity of coke substance, 1.90; apparent specific gravity of coke, 1.16; percentage of porosity, 39.
[b] Specific gravity of coke substance, 1.89; apparent specific gravity of coke, 1.08; percentage of porosity, 44.
[c] Specific gravity of coke substance, 1.89; apparent specific gravity of coke, 1.04; percentage of porosity, 46.

Chemical analyses of West Virginia No. 6 coal.

[Run-of-mine coal. Received from New River Smokeless Coal Company, Rush Run, W. Va.]

	Mine sample A.	Mine sample B.	Car sample.[a]	Sample from boiler test No. 39.[b]	Sample from boiler test No. 43.	Sample of coal from coke test No. 27.	Sample of coal from coke test No. 30.	Sample of coal from coke test No. 33, fine coal.	Coke sample, test No. 27.[c]	Coke sample, test No. 30.[d]	Coke sample, test No. 33.[e]
Laboratory sample number.....	1176	1175	1390	1314	1338	1316	1344	1378	1336	1370	1379
Loss of moisture on air drying, per cent........................	1.60	1.50	0.90	1.20	1.10	0.90	1.30	0.90	1.10	....	0.90
Analysis of air-dried sample:											
Proximate—											
Moisture .....per cent..	.51	.80	.64	.95	1.02	.87	.98	.84	1.75	....	1.00
Volatile matter ..do....	23.04	23.00	21.74	22.65	21.68	21.68	22.32	21.31	2.20	....	1.85
Fixed carbon.....do....	72.85	70.23	72.53	70.88	72.22	72.57	71.23	72.22	90.84	....	89.60
Ash ....do....	3.60	5.97	5.09	5.52	5.08	4.88	5.47	5.63	5.21	....	7.55
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		100.00
Ultimate—											
Hydrogen ....do....	....	....	4.70	....	....	....	....	....	....	....	....
Carbon ....do....	....	....	83.62	....	....	....	....	....	....	....	....
Nitrogen ....do....	....	....	1.70	....	....	....	....	....	....	....	....
Oxygen...........do....	....	....	4.23	....	....	....	....	....	....	....	....
Sulphur ....do....	.76	.74	.66	.71	.65	.56	.89	.64	.70	....	.70
Ash...............do....	....	....	5.09	....	....	....	....	....	....	....	....
			100.00								
Calorific value determined .... calories..	8,413	....	8,501	....	....	....	....	....	....	....	....
B. T. U..	15,143	....	14,942	....	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis............ calories..		....	8,208	....	....	....	....	....	....	....	....
B. T. U..	....	....	14,774	....	....	....	....	....	....	....	....
Phosphorus in coke............	....	....	....	....	....	....	....	....	.008	.007	.006
Sulphur in ash.................	....	....	....	....	....	....	....	....	.049	....	.076
Analysis corrected to sample as received:											
Proximate—											
Moisture......per cent..	2.10	2.29	1.53	2.14	2.11	1.76	2.27	1.75	2.83	.36	1.89
Volatile matter...do....	22.67	22.65	21.54	22.38	21.44	21.48	22.08	21.12	2.17	1.34	1.83
Fixed carbon.....do....	71.68	69.18	71.88	70.03	71.42	71.92	70.30	71.55	89.84	93.04	88.80
Ash..............do....	3.55	5.88	5.05	5.45	5.03	4.84	5.40	5.58	5.16	5.26	7.48
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—											
Hydrogen ....do....	....	....	4.76	....	....	....	....	....	....	....	....
Carbon ....do....	....	....	82.87	....	....	....	....	....	....	....	....
Nitrogen ....do....	....	....	1.68	....	....	....	....	....	....	....	....
Oxygen ....do....	....	....	4.99	....	....	....	....	....	....	....	....
Sulphur ....do....	.75	.73	.65	.70	.64	.55	.88	.63	.69	.76	.69
Ash...............do....	....	....	5.05	....	....	....	....	....	....	....	....
			100.00								
Calorific value determined.............. calories..	8,278	....	8,226	....	....	....	....	....	....	....	....
B. T. U..	14,900	....	14,807	....	....	....	....	....	....	....	....

[a] Represents 31 tons of coal.
[b] Refuse from boiler test, laboratory No. 1315: Combustible, 40.32 per cent; ash, 59.68 per cent.
[c] Specific gravity of coke substance, 1.77; apparent specific gravity of coke, 0.79; percentage of porosity, 55.
[d] Specific gravity of coke substance, 1.83; apparent specific gravity of coke, 0.84; percentage of porosity, 54.
[e] Specific gravity of coke substance, 1.79; apparent specific gravity of coke, 0.74; percentage of porosity, 59.
[d] Refuse from boiler test, laboratory No. 1339: Combustible, 43.02 per cent; ash, 56.98 per cent.

Chemical analyses of West Virginia No. 7 coal.

[Run-of-mine coal. Received from New River Smokeless Coal Company, Sun, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Car sample.[b]	Sample from boiler test No. 51.[c]	Sample from gas-producer test No. 23.	Sample of coal from coke test No. 7.	Coke sample, test No. 7.[d]
Laboratory sample number	1197	1198	1595	1609	1401	1607	1398	1414
Loss of moisture on air drying..per cent..	1.70	1.50	3.20	2.30	1.80	2.70	2.70	....
Analysis of air-dried sample:								
Proximate—								
Moisture ....do....	.80	.63	.76	.28	.90	.30	1.18	....
Volatile matter ....do....	21.65	22.07	20.54	20.69	20.60	21.78	21.12	....
Fixed carbon ....do....	73.33	73.70	73.61	69.87	69.52	71.06	72.54	....
Ash ....do....	4.22	3.60	5.09	9.16	8.98	6.86	5.16	....
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Ultimate—								
Hydrogen ....do....	....	....	4.38	....	....	....	....	....
Carbon ....do....	....	....	82.41	....	....	....	....	....
Nitrogen ....do....	....	....	1.05	....	....	....	....	....
Oxygen ....do....	....	....	5.87	....	....	....	....	....
Sulphur ....do....	1.10	.91	1.20	1.16	1.55	.95	1.39	....
Ash ....do....	....	....	5.09	....	....	....	....	....
			100.00					
Calorific value determined ... calories..	....	8,412	8,254	....	....	....	....	....
Calorific value determined ... B. T. U..	....	15,142	14,857	....	....	....	....	....
Calorific value calculated from ultimate analysis ... calories..	....	....	7,942	....	....	....	....	....
Calorific value calculated from ultimate analysis ... B. T. U..	....	....	14,296	....	....	....	....	....
Phosphorus in coke	....	....	....	....	....	....	....	0.0061
Sulphur in ash	....	....	....	....	....	....	....	.085
Analysis corrected to sample as received:								
Proximate—								
Moisture ....per cent..	2.48	2.12	3.94	2.57	2.68	2.99	3.85	.67
Volatile matter ....do....	21.28	21.74	19.88	20.22	20.23	21.19	20.55	1.23
Fixed carbon ....do....	72.09	72.59	71.25	68.27	68.27	69.15	70.58	90.40
Ash ....do....	4.15	3.55	4.93	8.94	8.82	6.67	5.02	7.70
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—								
Hydrogen ....do....	....	....	4.60	....	....	....	....	....
Carbon ....do....	....	....	79.78	....	....	....	....	....
Nitrogen ....do....	....	....	1.01	....	....	....	....	....
Oxygen ....do....	....	....	8.52	....	....	....	....	....
Sulphur ....do....	1.08	.90	1.16	1.13	1.52	.92	1.36	1.03
Ash ....do....	....	....	4.93	....	....	....	....	....
			100.00					
Calorific value determined ... calories..	....	8,286	7,990	....	....	....	....	....
Calorific value determined ... B. T. U..	....	14,915	14,882	....	....	....	....	....

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[a] Represents 10 tons of coal.

[b] Represents 5 tons of coal.

[c] Refuse from boiler test, laboratory No. 1402: Combustible, 34.60 per cent; ash, 65.40 per cent.

[d] Specific gravity of coke substance, 1.80; apparent specific gravity of coke, 0.80; percentage of porosity, 56.

Chemical analyses of West Virginia No. 8 coal.

[Run-of-mine coal. Received from Gauley Mountain Coal Company, Ansted, W. Va.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 53.[b]	Sample of coal from coke test No. 38.	Coke sample, test No. 38.[c]
Laboratory sample number		1257	1258	1515	1408	1406	1418
Loss of moisture on air drying	per cent	0.60	0.60	2.60	4.20	2.70	2.50
Analysis of air-dried sample:							
Proximate—							
Moisture	do	1.31	1.25	1.60	1.10	1.15	.30
Volatile matter	do	33.54	33.20	32.12	32.55	32.65	.55
Fixed carbon	do	60.25	58.75	58.92	59.18	58.80	84.47
Ash	do	4.90	6.80	7.36	7.17	7.40	14.68
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do			5.16			
Carbon	do			78.75			
Nitrogen	do			1.38			
Oxygen	do			6.43			
Sulphur	do	.64	.89	.92	.77	.91	.79
Ash	do			7.36			
				100.00			
Calorific value determined	calories	8,057		7,836			
	B. T. U.	14,539		14,153			
Calorific value calculated from ultimate analysis	calories			7,884			
	B. T. U.			14,091			
Phosphorus in coke							.0116
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent	1.90	1.84	4.16	5.26	3.82	2.79
Volatile matter	do	33.34	33.00	31.28	31.19	31.77	.53
Fixed carbon	do	59.89	58.40	57.39	56.68	57.21	82.37
Ash	do	4.87	6.76	7.17	6.87	7.20	14.31
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do			5.32			
Carbon	do			76.70			
Nitrogen	do			1.34			
Oxygen	do			8.57			
Sulphur	do	.64	.89	.90	.74	.89	.77
Ash	do			7.17			
				100.00			
Calorific value determined	calories	8,029		7,659	[d] 7,599		
	B. T. U.	14,452		13,786	[d] 13,678		

[a] Represents 35 tons of coal.
[b] Refuse from boiler test, laboratory sample No. 1409: Combustible, 23.64 per cent; ash, 76.36 per cent.
[c] Specific gravity of coke substance, 1.92; apparent specific gravity of coke, 1.01; percentage of porosity, 47.
[d] Derived from determinations on carload sample.

Chemical analyses of West Virginia No. 9 coal.

[Run-of-mine bituminous coal. Received from Vulcan mine, Mount Carbon Coal Company, Powellton, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 69.[b]	Sample from gas-producer test No. 17.	Sample of coal from coke test No. 50, unwashed.	Sample of coal from coke test No. 53, washed.	Coke sample, test No. 50.[c]	Coke sample, test No. 53.[d]	Sample from washery test, unwashed.	Sample of washed coal.
Laboratory sample number.....	1208	1209	1561	1508	1598	1489	1510	1503	1517	1561	1510
Loss of moisture on air drying, per cent......................	1.00	0.60	3.10	1.70	2.10	2.80	4.00	....	....	3.10	4.00
Analysis of air-dried sample:											
Proximate—											
Moisture......per cent..	.99	1.18	1.01	1.75	.57	1.04	1.82	....	....	1.01	1.82
Volatile matter...do....	34.76	32.72	29.53	31.65	32.68	31.98	33.48	....	....	....	....
Fixed carbon.....do....	60.45	63.14	62.67	60.50	60.90	58.68	60.01	....	....	....	....
Ash..............do....	3.80	2.96	6.79	6.10	5.85	8.30	4.69	....	....	6.79	4.69
	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
Ultimate—											
Hydrogen........do....	....	....	5.04	....	....	....	....	....	....	....	....
Carbon...........do....	....	....	79.35	....	....	....	....	....	....	....	....
Nitrogen.........do....	....	....	1.63	....	....	....	....	....	....	....	....
Oxygen..........do....	....	....	6.39	....	....	....	....	....	....	.80	.94
Sulphur..........do....	.86	.75	.80	.83	1.02	.85	.94	....	....	....	....
Ash..............do....	....	....	6.79	....	....	....	....	....	....	....	....
			100.00								
Calorific value determined: calories..	8,271	....	7,984	....	8,056	....	....	....	....	....	....
Calorific value determined: B. T. U..	14,888	....	14,371	....	14,501	....	....	....	....	....	....
Calorific value calculated from ultimate analysis: calories..	....	....	7,890	....	....	....	....	....	....	....	....
Calorific value calculated from ultimate analysis: B. T. U..	....	....	14,202	....	....	....	....	....	....	....	....
Phosphorus in coke..........	....	....	....	....	....	....	....	.0094	.012	....	....
Analysis corrected to sample as received:											
Proximate—											
Moisture......per cent..	1.98	1.77	4.08	3.42	2.66	3.81	5.74	.29	.27	4.08	5.74
Volatile matter...do....	34.41	32.53	28.61	31.11	32.00	31.08	32.14	2.41	.62	....	....
Fixed carbon.....do....	59.85	62.76	60.73	59.47	59.61	57.04	57.61	88.15	91.73	....	....
Ash..............do....	3.76	2.94	6.58	6.00	5.73	8.07	4.51	9.15	7.38	6.58	4.51
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Ultimate—											
Hydrogen........do....	....	....	5.23	....	....	....	....	....	....	....	....
Carbon...........do....	....	....	76.89	....	....	....	....	....	....	....	....
Nitrogen.........do....	....	....	1.58	....	....	....	....	....	....	....	....
Oxygen..........do....	....	....	8.95	....	....	....	....	....	....	....	....
Sulphur..........do....	.85	.74	.77	.82	1.00	.83	....	.82	.77	.77	.90
Ash..............do....	....	....	6.58	....	....	....	.90	....	....	....	....
			100.00								
Calorific value determined: calories..	8,188	....	7,736	....	[e]7,886	....	....	....	....	....	....
Calorific value determined: B. T. U..	14,738	....	13,925	....	[e]14,195	....	....	....	....	....	....

[a] Represents 30 tons of coal.

[b] Refuse from boiler test, laboratory No. 1509: Combustible, 23.68 per cent; ash, 67.32 per cent.

[c] Specific gravity of coke substance, 1.84; apparent specific gravity of coke, 1.18; percentage of porosity, 36.

[d] Specific gravity of coke substance, 1.87; apparent specific gravity of coke, 1.03; percentage of porosity, 45.

[e] Calorific value derived from determinations on the carload sample: 7,921 calories; 14,258 B. T. U.

Chemical analyses of West Virginia No. 10 coal.

[Lump and run-of-mine coal. Received from Stuart M. Buck, Mora, W. Va.]

	Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 54.[b]	Sample of coal from coke test No. 39.	Coke sample, test No. 39.[c]
Laboratory sample number	1240	1244	1471	1420	1415	1428
Loss of moisture on air drying........per cent..	2.40	2.30	1.10	1.20	0.90	3.10
Analysis of air-dried sample:						
Proximate—						
Moisture........do....	.55	.34	.65	.55	.73	.60
Volatile matter........do....	18.55	19.96	18.80	18.45	18.52	.55
Fixed carbon........do....	77.19	76.50	75.92	74.74	75.33	90.34
Ash........do....	3.71	3.20	4.63	6.26	5.42	8.51
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen........do....	....	....	4.58	....	....	....
Carbon........do....	....	....	85.91	....	....	....
Nitrogen........do....	....	....	1.07	....	....	....
Oxygen........do....	....	....	3.24	....	....	....
Sulphur........do....	.49	.58	.57	.60	.62	.58
Ash........do....	....	....	4.63	....	....	....
			100.00			
Calorific value determined........calories..	8,495	....	8,439	....	....	....
B. T. U..	15,291	....	15,190	....	....	....
Calorific value calculated from ultimate analysis...calories..	....	....	8,391	....	....	....
B. T. U..	....	....	15,104	....	....	....
Phosphorus in coke........	....	....	....	....	....	.007
Sulphur in ash........	....	....	....	....	....	.072
Analysis corrected to sample as received:						
Proximate—						
Moisture........per cent..	2.94	2.63	1.75	1.74	1.62	3.68
Volatile matter........do....	18.10	19.50	18.59	18.23	18.36	.53
Fixed carbon........do....	75.34	74.74	75.08	73.84	74.65	87.54
Ash........do....	3.62	3.13	4.58	6.19	5.37	8.25
	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen........do....	....	....	4.65	....	....	....
Carbon........do....	....	....	84.97	....	....	....
Nitrogen........do....	....	....	1.06	....	....	....
Oxygen........do....	....	....	4.18	....	....	....
Sulphur........do....	.48	.57	.56	.59	.61	.56
Ash........do....	....	....	4.58	....	....	....
			100.00			
Calorific value determined........calories..	8,291	....	8,346	....	....	....
B. T. U..	14,924	....	15,023	....	....	....

[a] Represents 10 tons of coal.

[b] Refuse from boiler test, laboratory No. 1421: Combustible, 41.90 per cent; ash, 58.10 per cent.

[c] Specific gravity of coke substance, 1.89; apparent specific gravity of coke, 0.99; percentage of porosity, 48.

Chemical analyses of West Virginia No. 11 coal.

[Run-of-mine bituminous coal. Received from mines Nos. 1 and 2, W. H. Coffman, Zenith, W. Va.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 56.[b]	Sample of coal from coke test No. 41.
Laboratory sample number		1234	1235	1472	1432	1429
Loss of moisture on air drying	per cent	1.50	2.60	3.30	4.20	4.70
Analysis of air-dried sample:						
Proximate—						
Moisture	do	.72	.46	.80	.68	.68
Volatile matter	do	18.56	18.74	16.90	17.02	16.72
Fixed carbon	do	75.40	76.11	70.80	71.36	72.15
Ash	do	5.32	4.69	11.50	10.94	10.45
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do	....	....	4.03	....	....
Carbon	do	....	....	79.12	....	....
Nitrogen	do	....	....	1.04	....	....
Oxygen	do	....	....	3.78	....	....
Sulphur	do	.45	.51	.53	.49	.49
Ash	do	....	....	11.50	....	....
				100.00		
Calorific value determined	calories	8,343	....	7,761	....	....
	B. T. U	15,017	....	13,970	....	....
Calorific value calculated from ultimate analysis	calories	....	....	7,631	....	....
	B. T. U	....	....	13,736	....	....
Analysis corrected to sample as received:						
Proximate—						
Moisture	per cent	2.21	3.05	4.07	4.85	5.35
Volatile matter	do	18.28	18.26	16.34	16.31	15.94
Fixed carbon	do	74.26	74.12	68.47	68.36	68.76
Ash	do	5.25	4.57	11.12	10.48	9.95
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do	....	....	4.27	....	....
Carbon	do	....	....	76.51	....	....
Nitrogen	do	....	....	1.00	....	....
Oxygen	do	....	....	6.59	....	....
Sulphur	do	.44	.50	.51	.47	.147
Ash	do	....	....	11.12	....	....
				100.00		
Calorific value determined	calories	8,218	....	7,505	....	....
	B. T. U	14,792	....	13,509	....	....

[a] Represents 10 tons of coal.

[b] Refuse from boiler test, laboratory No. 1431: Combustible, 26.13 per cent; ash, 73.87 per cent.

Chemical analyses of West Virginia No. 12 coal.

[Run-of-mine bituminous. Received from Big Sandy Coal and Coke Company, Big Sandy, W. Va.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample.[a]	Sample from boiler test No. 46.[b]	Sample from gas-producer test No. 8.	Sample of coal from coke test No. 32, unwashed
Laboratory sample number		1238	1242	1364	1374	1387	1372
Loss of moisture on air drying	per cent	1.60	2.90	1.10	0.80	0.50	0.70
Analysis of air-dried sample:							
Proximate—							
Moisture	do.	.32	.60	.62	.79	.93	.84
Volatile matter	do.	19.68	19.45	18.05	18.41	19.02	18.36
Fixed carbon	do.	75.54	75.93	74.38	75.94	73.57	74.60
Ash	do.	4.46	4.02	6.95	4.86	6.48	6.20
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.			4.36			
Carbon	do.			83.63			
Nitrogen	do.			1.34			
Oxygen	do.			3.03			
Sulphur	do.	.53	.75	.69	.60	.95	.98
Ash	do.			6.95			
				100.00			
Calorific value determined	calories	8,427	8,428	8,185		8,160	
	B. T. U.	15,169	15,170	14,733		14,688	
Calorific value calculated from ultimate analysis	calories			8,144			
	B. T. U.			14,659			
Analysis corrected to sample as received:							
Proximate—							
Moisture	per cent	1.92	3.48	1.72	1.58	1.43	1.53
Volatile matter	do.	19.36	18.89	17.85	18.26	18.93	18.23
Fixed carbon	do.	74.33	73.73	73.56	75.33	73.19	74.08
Ash	do.	4.39	3.90	6.87	4.83	6.45	6.16
		100.00	100.00	100.00	100.00	100.00	100.00
Ultimate—							
Hydrogen	do.			4.43			
Carbon	do.			82.71			
Nitrogen	do.			1.33			
Oxygen	do.			3.98			
Sulphur	do.	.52	.73	.68	.59	.95	.97
Ash	do.			6.87			
				100.00			
Calorific value determined	calories	8,292	8,184	8,095		[c] 8,119	
	B. T. U.	14,926	14,731	14,751		[c] 14,614	

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[a] Represents 40 tons of coal.

[b] Refuse from boiler test, laboratory No. 1375: Combustible, 45.43 per cent; ash, 54.57 per cent.

[c] Calorific value derived from determinations on the carload sample: 8,135 calories; 14,643 B. T. U.

Chemical analyses of West Virginia No. 12 coal—Continued.

[Run-of-mine bituminous. Received from Big Sandy Coal and Coke Company, Big Sandy, W. Va.]

	Sample from coke test No. 36, washed.	Coke sample, test No. 32.[a]	Coke sample, test No. 36.[b]	Sample from washery test, unwashed.	Sample of washed coal.	Sample of briquettes, boiler test No. 59.[c]
Laboratory sample number	1394	1388	1407	1364	1394	1441
Loss of moisture on air drying, per cent	7.10		4.20	1.10	7.10	0.40
Analysis of air-dried sample:						
Proximate—						
Moisture, do	1.36		1.00	.62	1.36	1.93
Volatile matter, do	19.59		.75			24.12
Fixed carbon, do	73.78		90.37			67.73
Ash, do	5.27		7.88	6.95	5.27	6.22
	100.00		100.00			100.00
Ultimate—						
Hydrogen, do						5.06
Carbon, do						83.18
Nitrogen, do						1.33
Oxygen, do						3.36
Sulphur, do	1.19		1.05	.69	1.19	.85
Ash, do						6.22
						100.00
Calorific value determined, calories						8,300
Calorific value determined, B. T. U.						14,940
Calorific value calculated from ultimate analysis, calories						8,339
Calorific value calculated from ultimate analysis, B. T. U.						15,010
Phosphorus in coke		0.0077	.01			
Sulphur in ash			.14			
Analysis corrected to sample as received:						
Proximate—						
Moisture, per cent	8.36	.35		1.72	8.36	2.32
Volatile matter, do	18.20	.85				24.02
Fixed carbon, do	68.54	89.37				67.46
Ash, do	4.90	9.43		6.87	4.90	6.20
	100.00	100.00				100.00
Ultimate—						
Hydrogen, do						5.08
Carbon, do						82.85
Nitrogen, do						1.32
Oxygen, do						3.71
Sulphur, do	1.11	.83		.68	1.11	.84
Ash, do						6.20
Calorific value determined, calories						8,267
Calorific value determined, B. T. U.						14,881

[a] Specific gravity of coke substance, 1.95; apparent specific gravity of coke, 0.90; percentage of porosity, 54.
[b] Specific gravity of coke substance, 1.88; apparent specific gravity of coke, 0.91; percentage of porosity, 52.
[c] Refuse from boiler test, laboratory No. 1442: Combustible, 32.77 per cent; ash, 67.23 per cent.

Chemical analyses of Wyoming No. 1 coal.

[Black lignite. Received from Wyoming Coal and Mining Company.]

		Mine sample No. 1.	Mine sample No. 2.	Car sample No. 1.[a]	Car sample No. 2.[b]	Sample from boiler test No. 63.[c]
Laboratory sample number		1368	1369	1479	1606	1467
Loss of moisture on air drying	per cent..	5.00	4.50	6.00	13.70	3.90
Analysis of air-dried sample:						
Proximate—						
Moisture	do...	17.89	17.74	17.69	9.42	18.64
Volatile matter	do...	37.81	38.91	37.96	40.63	42.21
Fixed carbon	do...	40.75	38.21	39.56	44.75	32.89
Ash	do...	3.55	5.14	4.79	5.20	6.26
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do...			6.09		
Carbon	do...			58.41		
Nitrogen	do...			1.09		
Oxygen	do...			28.99		
Sulphur	do...	.63	.56	.63	.56	.65
Ash	do...			4.79		
				100.00		
Calorific value determined	calories..	5,728		5,753		
	B. T. U...	10,310		10,355		
Calorific value calculated from ultimate analysis	calories..			5,582		
	B. T. U...			10,048		
Analysis corrected to sample as received:						
Proximate—						
Moisture	per cent..	22.00	21.44	22.63	21.83	21.81
Volatile matter	do...	35.92	37.16	35.68	35.06	40.56
Fixed carbon	do...	38.71	36.49	37.19	38.62	31.61
Ash	do...	3.37	4.91	4.50	4.49	6.02
		100.00	100.00	100.00	100.00	100.00
Ultimate—						
Hydrogen	do...			6.39		
Carbon	do...			54.91		
Nitrogen	do...			1.02		
Oxygen	do...			32.59		
Sulphur	do...	.60	.53	.59	.48	.63
Ash	do...			4.50		
				100.00		
Calorific value determined	calories..	5,442		5,408		
	B. T. U...	9,796		9,734		

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[a] Represents 5 tons of coal.
[b] Represents 17 tons of coal.
[c] Refuse from boiler test, laboratory No. 1468: Combustible, 59.81 per cent; ash, 40.19 per cent.

Chemical analyses of Wyoming No. 2 coal.

[Run-of-mine bituminous. Received from Antelope mines 1 and 2. Cambria Fuel Company, Cambria, Wyo.]

	Mine sample No. 1.	Mine sample No. 2.	Sample from boiler test No. 61.[a]	Sample from gas-producer test No. 16.
Laboratory sample number	1376	1377	1452	1571
Loss of moisture on air drying ... per cent..	4.70	3.80	3.00	6.90
Analysis of air-dried sample:				
Proximate—				
Moisture ... do....	4.09	5.64	8.35	2.73
Volatile matter ... do....	38.96	37.51	36.65	37.61
Fixed carbon ... do....	33.97	35.05	35.65	37.40
Ash ... do....	22.98	21.80	19.35	22.26
	100.00	100.00	100.00	100.00
Ultimate—				
Hydrogen ... do....				4.54
Carbon ... do....				55.29
Nitrogen ... do....				.80
Oxygen ... do....				12.94
Sulphur ... do....	5.18	4.50	3.99	4.17
Ash ... do....				22.26
				100.00
Calorific value determined ... calories..	5,660			5,758
Calorific value determined ... B. T. U..	10,188			10,364
Calorific value calculated from ultimate analysis ... calories..				5,567
Calorific value calculated from ultimate analysis ... B. T. U..				10,021
Analysis corrected to sample as received:				
Proximate:				
Moisture ... per cent..	8.60	9.23	11.10	9.44
Volatile matter ... do....	37.13	36.08	35.56	35.02
Fixed carbon ... do....	32.37	33.72	34.58	34.82
Ash ... do....	21.90	20.97	18.77	20.72
	100.00	100.00	100.00	100.00
Ultimate—				
Hydrogen ... do....				5.00
Carbon ... do....				51.46
Nitrogen ... do....				.74
Oxygen ... do....				18.17
Sulphur ... do....	4.94	4.33	3.87	3.91
Ash ... do....				20.72
				100.00
Calorific value determined ... calories..	5,394			5,361
Calorific value determined ... B. T. U..	9,709			9,650

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[a] Refuse from boiler test, laboratory No. 1451: Combustible, 13.86 per cent; ash, 86.14 per cent.

MISCELLANEOUS SAMPLES.

SAMPLES FROM TESTING PLANT.

Analyses were made of a number of samples from the testing plant which are not included in the list as classified by States. The results, with the records accompanying the samples, are as follows:

Chemical analyses of samples from a lot of 2,700 pounds of lignite received at the testing plant from Wilton, N. Dak.

	Sample taken just after mining. Laboratory number 1174.		Sample taken after passing through drier. Laboratory number 1186.	
	Air-dried sample.	Sample as received.	Air-dried sample.	Sample as received.
Loss on air drying	8.20		3.50	
Proximate analysis:				
Moisture	22.70	29.04	13.55	16.58
Volatile combustible	44.30	40.67	41.35	39.90
Fixed carbon	26.79	24.59	36.31	35.33
Ash	6.21	5.70	8.49	8.19
	100.00	100.00	100.00	100.00
Sulphur	.83	.76	1.42	1.37

Chemical analyses of samples of Texas lignite shipped to testing plant in sacks.

	Bottom and top. Laboratory number 1172.		Bottom. Laboratory number 1173.	
	Air-dried sample.	Sample as received.	Air-dried sample.	Sample as received.
Loss on air drying	[a]4.80		[a]3.60	
Proximate analysis:				
Moisture	20.99	24.78	22.48	25.27
Volatile combustible	37.96	36.14	31.3	30.23
Fixed carbon	20.73	19.73	26.73	25.77
Ash	20.32	19.35	19.43	18.73
	100.00	100.00	100.00	100.00
Sulphur	.69	.66	.56	.54

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[a] Samples not nearly air dry at test on reserve portion of No. 1173 six months later gave a further air-drying loss of 12.80 per cent. The volatile combustible matter was determined on this portion and corrected to original sample.

Chemical analyses of samples of Texas lignite shipped to testing plant in sacks—Continued.

	Laboratory number, 1173.	
	Air-dried sample.	Sample as received.
Ultimate analysis:		
Hydrogen	5.42	5.63
Carbon	42.36	40.83
Nitrogen	.78	.75
Oxygen	31.45	33.52
Sulphur	.56	.54
Ash	19.43	18.73
	100.00	100.00

Chemical analyses of samples of coke.

	Standard Connellsville 72-hour coke. Laboratory number, 1165.	Standard Connellsville 48-hour coke. Laboratory number, 1166.
Proximate analysis:[a]		
Moisture	0.23	0.19
Volatile combustible	1.32	.51
Fixed carbon	88.18	89.60
Ash	10.27	9.70
	100.00	100.00
Sulphur	.81	.63
Phosphorus	.017	.009
Specific gravity of the coke substance	1.90	1.90
Apparent specific gravity of the coke	1.00	1.00
Percentage of porosity	47	47

[a] Analysis of sample as received.

[illegible] of coke.

	[illegible] Laboratory number, 1498.	"M. S." = Milwaukee Solvay. Laboratory number, 1499.	"C." = Connellsville. Laboratory number, 1500.
[illegible]			
[illegible]	0.75	0.27	0.28
[illegible]	35	48	22
[illegible]	86.38	89.63	88.75
[illegible]	12.52	9.62	10.75
	100.00	100.00	100.00
[illegible]	.70	[illegible]	[illegible]
[illegible]	.012	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

Chemical analyses of pitches and asphalts—Continued.

	Laboratory sample number—				
	1464.[a]	1465.[b]	1555.[c]	1562.[d]	1563.[e]
Moisture	1.02	1.45	1.04	0.48	0.00
Volatile combustion	54.11	54.05	61.44	78.77	80.75
Fixed carbon	44.04	43.91	36.72	20.75	19.25
Ash	.83	.59	.80	.00	.00
	100.00	100.00	100.00	100.00	100.00
Sulphur	[f].66	[f].56			
Hydrogen	4.22	4.28			
Carbon	91.30	91.57			
Nitrogen	1.00	1.10			
Oxygen	1.99	1.90			

[a] Pitch E.
[b] Pitch D.
[c] Pitch H.
[d] Asphalt, Casper, Wyo.
[e] Asphalt, Gulf Refining Company.
[f] Determined by Eschka method, which usually gives low results for sulphur in pitch.

SAMPLES RECEIVED FROM THE FIELD.

Analyses were made of a number of mine samples which were sent to the chemical laboratory by field agents of the Survey, but which had no other connection with the work of the fuel-testing plant. For identification and description of these samples the reader is referred to the chapter on Field Work, page 31–155. These analyses are given in the following tables:

Chemical analyses of coals from Alabama.[a]

		Laboratory sample number—					
		1145.	1146.	1148.	1149.	1164.	1186.
Loss of moisture on air drying		6.80	1.70	2.80	2.20	2.80	1.50
Analysis of air-dried sample:							
Moisture		1.10	.95	.59	.73	1.04	.47
Volatile matter		26.45	26.95	26.51	24.62	31.06	32.03
Fixed carbon		62.08	60.66	62.97	54.41	57.61	61.89
Ash		10.37	11.44	9.93	20.24	10.29	5.61
		100.00	100.00	100.00	100.00	100.00	100.00
Sulphur		.96	.99	.96	.72	1.53	1.12
Calorific value determined	calories			7,800			8,101
	B. T. U			14,040			14,582

[a] See chapter on Field Work, page 40, for identification.

Chemical analyses of coals from Alabama—Continued.

		Laboratory sample number—					
		1145.	1146.	1148.	1149.	1164.	1166.
Analysis corrected to sample as received:							
Moisture		2.88	2.63	3.37	2.91	3.81	1.96
Volatile matter		25.98	26.49	25.77	24.08	30.19	31.55
Fixed carbon		60.96	59.63	61.21	53.21	55.99	60.96
Ash		10.18	11.25	9.65	19.80	10.01	5.53
		100.00	100.00	100.00	100.00	100.00	100.00
Sulphur		.94	.97	.94	.70	1.49	1.11
Calorific value determined	Calories			7,582			7,980
	B. T. U.			13,648			14,634

	Laboratory sample number—				
	1187.	1188.	1189.	1210.	1288.
Loss of moisture on air drying	3.40	1.50	3.70	1.30	0.80
Analysis of air-dried sample:					
Moisture	.47	.71	.79	1.06	1.29
Volatile matter	31.88	24.99	23.16	32.79	34.96
Fixed carbon	61.80	61.44	49.83	58.92	52.10
Ash	5.85	12.86	26.22	7.23	11.65
	100.00	100.00	100.00	100.00	100.00
Sulphur	.80	.55	1.37	1.39	1.58
Analysis corrected to sample as received:					
Moisture	3.85	2.20	4.46	2.35	2.08
Volatile matter	30.80	24.62	22.30	32.36	34.68
Fixed carbon	59.70	60.51	47.98	58.15	51.68
Ash	5.65	12.67	25.26	7.14	11.56
	100.00	100.00	100.00	100.00	100.00
Sulphur	.78	.54	1.32	1.37	1.57

Chemical analyses of coals from Arkansas.[a]

[Analyses made on samples as received.]

	Laboratory sample number—							
	1030.	1031.	1040.	1042.	1052.	1054.	1066.	1068.
Moisture	0.95	0.80	0.85	0.84	0.97	1.00	0.80	0.90
Volatile combustible	17.91	17.20	14.45	16.46	19.68	16.90	17.80	18.35
Fixed carbon	71.52	74.35	76.41	75.32	69.62	71.80	72.71	71.65
Ash	9.62	7.65	8.29	7.38	9.73	10.30	8.69	9.10
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	2.07	1.64	2.05	1.91	1.11	.60	1.95	1.74
Calorific value determined: calories	7,831			8,136	7,790		7,934	
Calorific value determined: B. T. U	14,096			14,645	14,022		14,281	

[a] See chapter on Field Work, page 49, for identification.

Chemical analyses of coals from Indiana.[a]

	Laboratory sample number—			
	1424.		1427.	
	Air-dried sample.	Sample as received.	Air-dried sample.	Sample as received.
Loss on air drying	3.60		3.50	
Moisture	7.06	10.41	6.07	9.36
Volatile combustible	40.64	39.18	39.73	38.34
Fixed carbon	43.53	41.96	44.32	42.77
Ash	8.77	8.45	9.88	9.53
	100.00	100.00	100.00	100.00
Sulphur	3.64	3.51	3.66	3.53

[a] See chapter on Field Work, page 66, for identification.

Calorific value of sample No. 1424 determined in the bomb calorimeter on the air-dried sample: Calories, 6,811; B. T. U., 12,260.

Calorific value corrected to the sample as received: Calories, 6,566; B. T. U., 11,819.

Chemical analyses of coals from Iowa.[a]

	Laboratory sample number—			
	1289.		1290.	
	Air-dried sample.	Sample as received.	Air-dried sample.	Sample as received.
Loss on air drying	6.60		10.40	
Moisture	5.81	12.03	6.07	15.84
Volatile combustible	43.49	40.62	41.18	36.90
Fixed carbon	40.65	37.97	42.28	37.88
Ash	10.05	9.38	10.47	9.38
	100.00	100.00	100.00	100.00
Sulphur	5.41	5.04	5.22	4.68

[a] See chapter on Field Work, page 81, for identification.

Calorific value of sample No. 1290 determined in the bomb calorimeter on the air-dried sample: Calories, 6,730; B. T. U., 12,114.

Calorific value corrected to the sample as received: Calories, 6,030; B. T. U., 10,854.

Chemical analyses of coals from Kentucky.[a]

	Laboratory sample number—			
	1329.		1330.	
	Air-dried sample.	Sample as received.	Air-dried sample.	Sample as received.
Loss on air drying	2.60		2.40	
Moisture	2.48	5.02	3.19	5.51
Volatile combustible	37.04	36.08	36.11	35.24
Fixed carbon	55.93	54.47	58.09	56.70
Ash	4.55	4.43	2.61	2.55
	100.00	100.00	100.00	100.00
Sulphur	.94	.92	.92	.90

[a] See chapter on Field Work, page 95, for identification.

Calorific value of sample No. 1329 determined in the bomb calorimeter on the air-dried sample: Calories, 7,762; B. T. U., 13,972.

Calorific value corrected to the sample as received: Calories, 7,560; B. T. U., 13,608.

Chemical analyses of coals from Missouri.[a]

[Analyses made of samples as received.]

	Laboratory sample number—	
	1010.	1011.
Moisture	11.27	11.08
Volatile combustible	33.44	35.85
Fixed carbon	41.49	39.77
Ash	13.80	13.30
	100.00	100.00
Sulphur	2.48	2.86

[a] See chapter on Field Work, page 102, for identification.

Calorific value of sample No. 1011 determined in the bomb calorimeter on sample as received: Calories, 6,087; B. T. U., 10,957.

Chemical analyses of coals from New Mexico.[a]

[Analyses made of samples as received.]

	Laboratory sample number—		
	1012.	1013.	1056.
Moisture	7.81	9.68	6.55
Volatile combustible	44.72	42.32	25.75
Fixed carbon	41.80	41.36	44.28
Ash	5.67	6.64	23.42
	100.00	100.00	100.00
Sulphur	.69	.66	.45

[a] See chapter on Field Work, pages 106-107, for identification of sample 1012. No. 1013 is from Sloan mine, 8 miles east of Algodones. No. 1056 is from Brooks's mine, east of Albuquerque.

Chemical analyses of coals from Ohio.[a]

	Laboratory sample number—			
	1574.	1575.	1576.	1577.
Loss of moisture on air drying	1.90	2.80	3.80	2.90
Analysis of air-dried sample:				
Moisture	2.03	2.46	2.86	2.44
Volatile matter	37.17	35.69	35.84	35.91
Fixed carbon	53.26	52.13	52.35	50.63
Ash	7.54	9.72	8.95	11.02
	100.00	100.00	100.00	100.00
Sulphur	3.70	2.45	2.62	3.16
Analysis corrected to sample as received:				
Moisture	3.89	5.19	6.55	5.27
Volatile matter	36.46	34.69	34.48	34.87
Fixed carbon	52.25	50.67	50.36	49.16
Ash	7.40	9.45	8.61	10.70
	100.00	100.00	100.00	100.00
Sulphur	3.63	2.38	2.52	3.07

[a] See chapter on Field Work, page 112-113, for identification.

Chemical analyses of coals from Pennsylvania.[a]

	Laboratory sample number—						
	1032.	1033.	1034.	1035.	1047.	1048.	1050.
Moisture	1.90	1.70	1.46	1.72	1.22	3.35	1.05
Volatile matter	36.20	37.20	35.56	36.98	36.28	35.55	36.65
Fixed carbon	53.70	55.83	53.39	56.55	56.24	47.55	57.25
Ash	8.20	5.27	9.59	4.75	6.26	13.55	5.05
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	1.52	1.13	2.05	1.15	.84	1.41	.91
Calorific value determined. calories		7,964			7,915		
Calorific value determined. B. T. U.		14,335			14,247		

[a] See chapter on Field Work, page 112-113, for identification.

Chemical analyses of coals from Pennsylvania—Continued.

	Laboratory sample number—						
	1051.	1055.	1065.	1067.	1069.	1070.	1072.
Moisture	2.48	1.37	2.15	2.51	2.95	1.95	1.54
Volatile matter	38.74	37.10	39.15	35.49	35.75	39.05	38.21
Fixed carbon	49.18	53.84	52.65	50.15	48.65	47.30	48.57
Ash	9.60	7.69	6.05	11.85	12.65	11.70	11.68
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	1.85	1.61	3.64	3.24	3.29	3.87	4.12
Calorific value determined: calories	7,318						
Calorific value determined: B. T. U.	13,172						

	Laboratory sample number—						
	1239.	1585.	1588.	1589.	1590.	1591.	1592.
Loss of moisture on air drying	0.50	1.20	1.70	1.30	1.60	1.20	1.40
Analysis of air-dried sample:							
Moisture	1.73	1.61	1.22	.98	2.06	1.87	1.18
Volatile matter	36.97	36.49	32.23	32.82	34.79	38.78	33.62
Fixed carbon	47.20	48.93	46.55	47.75	51.95	52.85	48.01
Ash	14.10	12.97	20.00	18.45	11.20	6.50	17.19
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	3.81	3.51	4.51	2.93	1.93	1.78	3.27
Analysis corrected to sample as received:							
Moisture	2.22	2.79	2.90	2.27	3.63	3.05	2.56
Volatile matter	36.79	36.05	31.68	32.39	34.23	38.32	33.15
Fixed carbon	46.96	48.35	45.76	47.13	51.12	52.21	47.34
Ash	14.03	12.81	19.66	18.21	11.02	6.42	16.95
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	3.79	3.47	4.43	2.89	1.90	1.76	3.22

Chemical analyses of coals from West Virginia.[a]

	Laboratory sample number—					
	1233.	1236.	1257.	1562.	1563.	1572.
Loss of moisture on air drying	0.90	0.60	1.30	1.00	1.10	4.00
Analysis of air-dried sample:						
Moisture	1.39	1.68	.99	1.30	1.75	2.56
Volatile matter	31.48	33.87	34.66	32.25	33.90	35.29
Fixed carbon	49.47	55.98	57.37	51.83	53.92	51.82
Ash	17.66	8.47	6.98	14.62	10.43	10.33
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	.69	1.06	3.18	1.21	.65	5.25
Analysis corrected to sample as received:						
Moisture	2.28	2.27	2.28	2.29	2.83	6.46
Volatile matter	31.20	33.67	34.21	31.93	33.53	33.88
Fixed carbon	49.02	55.64	56.61	51.31	53.32	49.74
Ash	17.50	8.42	6.90	14.47	10.32	9.92
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	.68	1.05	3.14	1.20	.64	5.04

	Laboratory sample number—					
	1578.	1579.	1580.	1581.	1582.	1583.
Loss of moisture on air drying	0.80	5.00	1.00	1.40	2.30	3.40
Analysis of air-dried sample:						
Moisture	1.52	2.00	1.92	1.01	1.24	2.11
Volatile matter	31.18	30.15	37.38	33.49	32.36	29.14
Fixed carbon	57.99	59.57	52.49	60.34	61.67	62.27
Ash	9.31	8.28	8.21	5.16	4.73	6.48
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	1.28	.75	2.71	.53	.74	.69
Analysis corrected to sample as received:						
Moisture	2.31	6.90	2.90	2.40	3.51	5.44
Volatile matter	30.93	28.64	37.01	33.02	31.62	28.15
Fixed carbon	57.52	56.59	51.96	59.49	60.25	60.15
Ash	9.24	7.87	8.13	5.09	4.62	6.26
	100.00	100.00	100.09	100.00	100.00	100.00
Sulphur	1.27	.71	2.69	.52	.72	.67

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[a] See chapter on Field Work, page 136, for identification.

Chemical analyses of coals from West Virginia—Continued.

	Laboratory sample number—		
	1584.	1586.	1594.
Loss of moisture on air drying	2.80	2.90	2.90
Analysis of air-dried sample:			
Moisture	2.33	1.88	1.29
Volatile matter	33.97	37.52	37.86
Fixed carbon	51.93	52.65	51.40
Ash	11.77	7.95	9.45
	100.00	100.00	100.00
Sulphur	2.82	2.92	5.25
Analysis corrected to sample as received:			
Moisture	5.06	4.73	4.15
Volatile matter	33.02	36.43	36.76
Fixed carbon	50.48	51.12	49.91
Ash	11.44	7.72	9.18
	100.00	100.00	100.00
Sulphur	2.74	2.84	5.10

EXPERIMENTAL TESTS AND OTHER SPECIAL WORK.

SULPHUR RETAINED IN RESIDUES FROM WATER EXTRACTION IN ESCHKA METHOD.

The residues from a number of determinations, as well as from several blanks on the reagents, were dissolved in a slight excess of hydrochloric acid, the solution was filtered, and the filtrate was examined for sulphur with barium chloride. The precipitates obtained were small and when ignited were always gray in color, but were in all cases weighable. A number were tested for silica by treating them with hydrofluoric acid. The resultant loss in weight was only a few tenths of a milligram, showing that the precipitates treated were not due to silica. The amount of precipitate obtained did not appear to bear any particular relation to the percentage of sulphur in the coal, and in some cases was no larger than that from the residue when using the reagents alone. The results obtained from the residues of the blanks were as follows:

Weight of the precipitate in grams.	Per cent of sulphur estimated as from 1 gram of coal.
0.0015	0.021
.0015	.021
.0013	.018
.0011	.015
.0024	.033
.0014	.019
[a].0015	[a].021

[a] Average.

The following table gives the results obtained on the samples tested. The percentage of sulphur remaining in the residue as given in the table is that obtained by deducting the average from the reagents (0.021) from the total amount equivalent to the precipitate of barium sulphate.

Amount of sulphur retained in residues from water extraction by Eschka method.

Sample number.	Per cent of sulphur found in sample.	Per cent of sulphur remaining in the residue.	Sample number.	Per cent of sulphur found in sample.	Per cent of sulphur remaining in the residue.
1010	2.48	0.031	1032	1.52	0.041
		.034	1030	2.07	.000
1011	2.86	.023	1033	1.13	.002
		.045	1042	1.91	.000
1016	3.70	.044	1043	5.34	.041
1017	5.63	.045	1045	1.10	.020
1018	3.79	.040	1086	5.68	.047
1020	3.28	.035	1087	5.68	.081
1023	.55	.009	1090	4.85	.035
1021	3.00	.057	1095	4.41	.031
1025	.48	.025	1097	4.34	.051
1028	1.55	.045	1126	5.53	.041
1029	.84	.033			

COMPARISON OF SULPHUR OBTAINED IN WASHINGS FROM MAHLER BOMB CALORIMETER WITH RESULTS BY ESCHKA METHOD.

The calorimeter bomb was washed out eight to twelve times, about 25 cc. of water being used for each washing. This amount of washing was found to be necessary in order to obtain all the sulphur.

The washings were acidified with hydrochloric acid, and the sulphur was precipitated and weighed as barium sulphate. The following table gives the results by the two methods. Duplicate determinations by the Eschka method were made upon most of the samples in the list. With the samples of pitch the results from the calorimeter are higher than by the Eschka method, probably because it was almost impossible to completely burn these samples by the Eschka method on account of the fusing of the mass. The results on the air-dried samples are given in the following table:

Comparison of sulphur obtained in washings from Mahler bomb calorimeter with results by Eschka method.

Number.	Name of coal.	Sulphur by Eschka method.	Sulphur by Mahler calorimeter.
		Per cent.	*Per cent.*
1011	Missouri coal	2.88 2.85	2.82
1016	Illinois coal	3.52? 3.70	3.61
1021	.....do	2.93 3.00 2.89	3.04
1026	New Mexico No. 1	.55	.55
1028	New Mexico No. 2	1.55	1.55
1030	Arkansas coal	2.00 2.13	2.14
1033	Pennsylvania coal	1.12 1.13	1.14
1037	Kansas No. 3	4.47	4.43
1039	Pennsylvania coal	1.49	1.56
1042	Arkansas coal	1.91	1.97
1043	Missouri No. 1	5.31 5.29 5.42	5.25
1045	Arkansas No. 1	1.10	1.15
1047	Pennsylvania coal	.84	.85
1051	.....do	1.84	1.93 1.96
1052	Arkansas coal	1.11	1.22
1057	Pennsylvania coal	.92	.91
1059	Indian Territory No. 1	1.71	1.59 1.77
1061	Kansas No. 3	5.41	5.47 5.30
1066	Arkansas coal	1.95	1.99
1071	Indian Territory No. 2	1.38	1.41
1075	Alabama No. 2	1.09	1.08
1076	.....do	1.11 1.09	1.15 1.14 1.18
1078	Alabama No. 1	.71	.77
1080	Indian Territory No. 3	3.73	3.40 3.55 3.59
1086	Kansas No. 3	5.66 5.69	[a] [b] 5.37 [a] 6.14
1088	West Virginia No. 1	1.60	1.65 1.63
1095	Illinois Nos. 1 and 2	4.38 4.44	4.42
1097	Kansas No. 1	4.32 4.36	4.20 4.25
1103	West Virginia No. 2	4.24	4.38 4.18
1105	Arkansas No. 1	1.22	1.28
1108	West Virginia No. 3	.77	.82
1112	Briquette, Arkansas coal	1.37	1.39
1114	Arkansas No. 1	1.27 1.27	1.33 1.33
1115	Arkansas coal	1.43	1.47 1.48
1116	West Virginia No. 4	.86	.87
1122	Kansas No. 2	6.34 6.46	6.38 6.50 6.39 6.40
1125	Pitch	.61	.89 .88
1126	Missouri No. 1	5.51 5.54	5.41 5.60 5.68
1130	Arkansas coal	1.53	1.59 1.63
1135	Briquette, Arkansas coal	1.73	1.79
1138	Indian Territory No. 1	1.96 2.01	1.98 1.93
1144	West Virginia No. 5	1.02	1.13
1151	Indian Territory No. 4	3.74	3.67
1152	Illinois No. 2	4.32 4.28	4.19
1160	Arkansas No. 2	1.82 1.96	1.96 1.92 1.96
1163	Indian Territory No. 4	1.45	1.42
1170	Illinois No. 3	1.00	1.00
1176	West Virginia No. 6	.76	.77 .76

[a] Only 100 cc. of water used for washing the first; the second was run directly afterwards, using 200 cc. of water for washing.

[b] Average=5.75.

Comparison of sulphur obtained in washings from Mahler bomb calorimeter with results by Eschka method—Continued.

Number.	Name of coal.	Sulphur by Eschka method.	Sulphur by Mahler calorimeter.
		Per cent.	*Per cent.*
1184	Indian Territory No. 2	1.55 1.56	1.54 1.54
1186	Alabama coal	1.12	1.01
1194	Briquette, Alabama No. 1	.96 .94	1.11
1196	Texas No. 1	.65 .67	.67
1201	Alabama No. 1	.72 .74	.77
1213	West Virginia No. 1	.91 .88	.89
1215	....do	.99	1.01
1225	Alabama No. 2	1.03 1.00	1.08 1.08
1226	Missouri No. 2	4.00	4.20
1234	West Virginia No. 11	.45	.53
1452	Pennsylvania (anthracite) No. 3	.77	.74
1252	West Virginia No 3	1.08 1.06	1.06 1.08
1261	Illinois No. 1	4.25 4.30	4.19
1262	West Virginia No. 4	.89 .90	.93
1270	Iowa No. 1	5.12	5.06
1274	Indian Territory No. 3	3.68 3.65	3.64
1278	New Mexico No. 1	.62 .66	.67
1293	Briquette, Arkansas coal	1.43	1.46
1279	North Dakota No. 1	2.02 1.97	2.01
1294	Briquette, Pennsylvania No. 3	1.13	1.21
1296	Arkansas coal	1.33 1.28	1.29
1297	West Virginia No. 5	.99 1.01	1.03
1298	Montana No. 1	1.76 1.77	1.72
1307	New Mexico No. 2	1.29 1.30	1.31
1308	West Virgina No. 2	3.47 3.53	3.48
1311	Pitch	.51	.70
1318	Illinois No. 3	1.81 1.72	1.76
1320	Briquette, Arkansas coal	1.68	1.87
1331	Arkansas coal	2.05 1.98	1.96
1335	Briquette, Arkansas coal	1.70	1.71
1341	Illinois No. 4	.86	.85
1347	Iowa No. 1	5.21 5.07 5.30	5.21
1348	Missouri No. 2	5.27 5.32	5.23
1364	West Virginia No. 12	.67 .71	.71
1390	West Virginia No. 6	.67 .65	.65
1391	Pitch	.48	.57
1416	North Dakota No. 2	.56 .65	.63 .63
1417	Illinois No. 4	1.34 1.46	1.27
1430	North Dakota No. 2	1.38	1.29
1433	Iowa coal	3.42 3.37 .37 3.52	3.22
1434	....do	6.86 6.80	6.70
1437	....do	4.48 4.43	4.45
1441	West Virginia No. 12, briquette	.85	.84
1456	Texas No. 1	1.04	.91
1461	Kentucky No. 3	3.87 3.63	3.67
1470	Indian Territory No. 4	4.02 4.03	3.96
1471	West Virginia No. 10	.55 .59	.53
1472	West Virginia No. 11	.53 .53	.53
1473	Kansas No. 4	8.42 8.27	8.42
1474	Kentucky No. 1	1.25	1.24
1479	Wyoming No. 1	.64	.63
1481	Indian Territory No. 5	4.15	4.06
1488	Briquette, Iowa coal	4.11	4.05
1495	Indiana No. 3	4.52 4.62	4.64
1506	Kentucky No. 4	3.66 3.52	3.60
1515	West Virginia No. 8	.92	.90
1516	Missouri No. 4	5.49 5.44	5.62
1521	Indiana No. 1, briquette	2.11	2.04
1523	Colorado No. 1	.55 .57	.60

COMPARISON OF RESULTS OBTAINED FOR PHOSPHORUS IN COKE BY DIRECT WEIGHING OF THE YELLOW PRECIPITATE WITH CONTROL TESTS BY THE MAGNESIA METHOD.

After the yellow precipitate obtained in the determination of the phosphorus was weighed, several of the precipitates were combined and dissolved in ammonia, and the phosphorus was then determined in the solution by precipitation with "magnesia mixture." From the weight of the $Mg_2P_2O_7$ obtained and the amount of the coke represented by the several precipitates dissolved, the percentage of phosphorus in the combined sample was calculated and compared with the average of the several determinations represented by the individual yellow precipitates.

As 6.52 grams were taken for each determination the effect of combining five in this was to give a magnesia determination upon 32.6 grams of coke.

The yellow precipitates from the determinations on samples Nos. 1211, 1212, 1219, 1219, 1220, 1246, 1246, 1247, and 1248 were combined and the phosphorus was determined by the magnesia method. The results by the two methods were as follows:

Average by weighing yellow precipitate, 0.034 per cent.
Average by weighing as $Mg_2P_2O_7$, 0.031 per cent.

On samples Nos. 1336, 1343, 1370, 1343, and 1371 the results were:

Weighing yellow precipitate, 0.0206 per cent.
Weighing as $Mg_2P_2O_7$, 0.0209 per cent.

On samples Nos. 1379, 1388, 1399, 1388, and 1400:

Weighing yellow precipitate, 0.0105 per cent.
Weighing as $Mg_2P_2O_7$, 0.0104 per cent.

On samples Nos. 1407, 1414, 1418, 1414, and 1428:

Weighing yellow precipitate, 0.0081 per cent.
Weighing as $Mg_2P_2O_7$, 0.0061 per cent.

On samples Nos. 1455, 1458, 1475, 1458, and 1484:

Weighing yellow precipitate, 0.022 per cent.
Weighing as $Mg_2P_2O_7$, 0.017 per cent.

On samples Nos. 1493, 1493, 1494, 1494, and 1503:

Weighing yellow precipitate, 0.0169 per cent.
Weighing as $Mg_2P_2O_7$, 0.0169 per cent.

On samples Nos. 1500, 1511, 1500, 1514, 1517, and 1519:

Weighing yellow precipitate, 0.0172 per cent.
Weighing as $Mg_2P_2O_7$, 0.016 per cent.

On samples Nos. 1514, 1517, 1535, 1535, 1547, and 1547:

Weighing yellow precipitate, 0.0292 per cent.
Weighing as $Mg_2P_2O_7$, 0.026 per cent.

COMPARISON OF NITROGEN IN THE MINE SAMPLES AND CAR SAMPLES.

In the table which follows the results on the car samples are the averages of duplicates. The results on the mine samples were not duplicated. The agreement of the results on the mine and the car samples is fairly satisfactory with most of the coals. In some cases, where considerable difference appears, the samples were widely different in moisture, ash, and sulphur. It is, however, probable that the larger differences are to be attributed to actual variations in the coals.

Comparison of nitrogen in mine samples and car samples.

State and number.	Car sample.		Mine sample.	
	Sample number.	Per cent nitrogen.	Sample number.	Per cent nitrogen.
Alabama, No. 1	1201	1.66	1077	1.43
Alabama, No. 2	1225	1.55	1075	1.64
Arkansas, No. 1	1114	1.47	1045	1.71
Arkansas, No. 2	1160	1.40	1049	1.71
Arkansas	1331	1.39	1130	1.41
Do	1296	1.55	1115	1.40
Colorado, No. 1	1523	1.22	1383	1.23
Illinois, No. 1	1261	1.07	1095	.92
Illinois, No. 2	1152	.78	1095	.92
Illinois, No. 3	1318	1.43	1170	1.43
Illinois, No. 4	1470	1.38	1151	1.31
Indiana, No. 1	1507	1.22	1412	1.26
Indian Territory, No. 1	1138	1.29	1059	1.44
Indian Territory, No. 2	1184	1.72	1071	1.70
Indian Territory, No. 3	1274	1.50	1079	1.39
Indian Territory, No. 4	1470	1.38	1151	1.31
Indian Territory, No. 5	1481	1.22	1151	1.31
Iowa, No. 1	1347	.97	1270	1.02
Iowa	1570	1.46	1289	1.16
Kansas, No. 1	1097	1.09	1018	1.09
Kansas, No. 2	1122	.94	1017	1.21
Missouri, No. 1	1126	.99	1041	1.16
New Mexico, No. 1	1278	1.05	1023	1.14
New Mexico, No. 2	1307	.98	1028	1.00
Texas, No. 2	1597	1.06	1241	.85
West Virginia, No. 1	1213	1.55	1088	1.44
West Virginia, No. 2	1308	1.37	1103	1.29
West Virginia, No. 3	1252	1.44	1108	1.36
West Virginia, No. 4	1262	1.50	1116	1.31
West Virginia, No. 5	1297	1.48	1144	1.29
West Virginia. No. 7	1595	1.05	1198	1.50
Wyoming, No. 2	1571	.80	1376	.68

EXPERIMENTAL WORK ON SAMPLING.

The preparation from the coal tested of a laboratory sample which would properly represent the average composition not only of the carload but of the several portions used in the various tests was recognized from the start as a very difficult problem.

It was originally planned to take the car sample by means of an automatic sampler and on a much larger scale than was possible by hand sampling. The working conditions of the plant, however, precluded the carrying out of this idea. The original plan was to deflect about 5 per cent of the coal from the conveyors into a special bin, which would give a sample of about 2 tons from a 40-ton car. This was then to be recrushed and passed through the same sampler, which would deflect 5 per cent the second time. This final 200 pounds was then to be hand sampled as before.

This plan required that the whole car be unloaded at one time, and as this could not be done in most cases, recourse to the method of sampling described in this report was necessary.

In order to compare the general results obtained by sampling the following table is given. It shows the results for moisture, ash, and sulphur on all those coals on which three or more large samples were taken at the plant. In all cases the results given are those for the sample as received and include the air-drying loss.

Table of results on coals of which three or more samples were taken at the testing plant.

	Mine samples.		Testing-plant samples.				Average of plant samples.
	A.	B.	Car.	Steam.	Coke.	Gas.	
Alabama No. 1 (car sample from 20 tons lump and nut):							
Moisture	1.22	1.35	2.34	2.56	2.65	....	2.52
Ash	12.81	13.63	12.54	13.92	13.88	....	13.45
Sulphur	.71	.71	.72	.78	.76	....	.75
Alabama No. 2 (car sample from 27 tons lump, nut, and pea coal):							
Moisture	2.25	2.42	3.36	4.83	3.77	3.76	3.93
Ash	9.04	11.13	12.43	13.54	13.04	9.50	12.13
Sulphur	1.09	1.10	1.01	1.17	1.43	.86	1.12
Arkansas No. 1 (car sample from 38 tons lump and nut):							
Moisture	1.02	.75	3.24	1.99	2.31	....	2.51
Ash	7.49	6.48	12.61	13.04	13.01	....	12.89
Sulphur	1.10	1.15	1.24	1.21	1.13	....	1.19
Arkansas No. 2 (car sample from 15 tons lump and nut):							
Moisture	.95	.78	2.23	1.07	2.31	....	1.87
Ash	6.97	9.09	9.20	8.42	10.55	....	9.39
Sulphur	2.12	2.50	1.87	1.95	1.58	....	1.80

Table of results on coals of which three or more samples were taken at the testing plant—Continued.

	Mine samples.		Testing-plant samples.				Average of plant samples.
	A.	B.	Car.	Steam.	Coke.	Gas.	
Colorado No. 1 (car sample from 20 tons lump and nut):							
Moisture	20.02	21.84	18.86	19.78	....	20.24	19.63
Ash	3.61	3.48	5.99	5.37	....	5.85	5.74
Sulphur	.52	.46	.55	.42	....	.60	.52
Illinois No. 1 (car sample from 15 tons lump and nut):							
Moisture	11.17	10.06	9.75	9.69	10.46	....	9.97
Ash	10.32	10.07	13.20	15.19	15.95	....	14.78
Sulphur	4.22	4.04	4.10	4.40	4.14	....	4.21
Illinois No. 3 (car sample, 40 tons, run of mine):							
Moisture	7.50	7.34	8.50	8.51	8.25	7.62	8.22
Ash	7.15	7.58	11.28	11.55	10.59	9.73	10.79
Sulphur	.99	2.04	1.72	1.50	1.45	1.69	1.59
Illinois No. 4 (car sample from 22 tons lump coal):							
Moisture	15.09	14.42	12.91	13.47–12.58	....	12.43	12.85
Ash	7.42	8.81	11.64	11.46–11.35	....	9.22	10.92
Sulphur	.83	1.52	1.32	1.28– 1.36	....	1.41	1.34
Indiana No. 2 (car sample, 30 tons, run of mine):							
Moisture	9.28	10.32	9.62	9.11	....	8.72	9.15
Ash	9.34	8.55	13.02	12.45	....	9.73	11.73
Sulphur	4.44	3.51	4.43	4.12	....	4.23	4.26
Indian Territory No. 1 (car sample from 40 tons lump and slack):							
Moisture	8.87	6.77	7.04	7.65	10.29	5.00	7.49
Ash	8.63	5.68	10.01	12.09	13.86	8.51	11.12
Sulphur	1.62	1.36	1.92	1.80	1.34	1.43	1.62
Indian Territory No. 2 (car sample from 20 tons run of mine):							
Moisture	1.46	1.30	4.45	3.71	3.82	....	3.99
Ash	6.40	7.65	11.00	9.77	9.99	....	10.25
Sulphur	1.38	1.58	1.52	1.39	1.47	....	1.46
Indian Territory No. 3 (car sample from 25 tons run of mine):							
Moisture	2.97	2.93	4.61	4.79	4.16	....	4.52
Ash	8.38	10.30	11.14	10.33	9.75	....	10.41
Sulphur	3.05	3.73	3.63	3.93	3.16	....	3.57
Indian Territory No. 4 (car samples, 5 tons each, lump coal):							
Moisture	5.29	6.50	6.24– 8.35	6.24	....	9.00	7.46
Ash	12.13	9.31	13.21–12.57	12.99	....	16.36	13.78
Sulphur	3.77	3.67	3.96– 3.79	3.86	....	4.12	3.93
Iowa No. 2 (car samples, 10 tons and 6 tons, run of mine):							
Moisture	15.65	15.50	14.21–16.99	14.88	....	16.69	15.69
Ash	11.64	9.19	15.22–14.46	16.04	....	20.70	16.60
Sulphur	5.10	5.19	4.66– 5.15	4.73	....	5.50	5.01
Kansas No. 1 (car sample, 22 tons):							
Moisture	2.91	3.50	4.99	5.90– 4.80	8.10	....	5.95
Ash	9.55	7.92	12.97	10.86–13.95	14.82	....	13.15
Sulphur	3.79	3.28	4.28	3.82– 4.94	4.48	....	4.38
Kansas No. 3 (car sample, 7 tons, run of mine):							
Moisture	2.01	2.54	2.50	2.03– 2.25	1.75	....	2.13
Ash	15.15	9.87	12.45	13.46–12.40	16.91	....	13.80
Sulphur	5.27	4.47	5.68	5.39– 4.80	5.60	....	5.37

Table of results on coals of which three or more samples were taken at the testing plant—Continued.

	Mine samples.		Testing-plant samples.				Average of plant samples.
	A.	B.	Car.	Steam.	Coke.	Gas.	
Kansas No. 4 (car samples, 10 tons, lump coal):							
Moisture	....	....	6.95	5.51	6.63	....	6.36
Ash	....	....	12.19	14.58	12.93	....	13.23
Sulphur	....	....	8.04	8.46	7.19	....	7.90
Kansas No. 5 (car samples, 7 and 30 tons, lump and nut):							
Moisture	5.11	5.79	4.10- 4.60	4.31	....	4.35	4.34
Ash	8.90	12.55	10.54-11.31	11.91	....	11.25	11.25
Sulphur	4.34	3.84	3.77- 3.40	4.40	....	3.00	3.64
Kentucky No. 1 (car samples, 23 and 12 tons, run of mine):							
Moisture	2.91	2.81	3.10- 2.95	2.89	2.71	....	2.91
Ash	3.53	2.80	4.39- 5.77	5.91	3.90	....	4.99
Sulphur	.89	.84	1.22- 1.20	1.19	1.23	....	1.21
Missouri No. 2 (car sample, 32 tons, run of mine):							
Moisture	14.74	12.90	11.50	13.09-11.57	....	11.60	11.94
Ash	7.78	10.66	16.86	16.70-16.90	....	14.84	16.32
Sulphur	3.79	3.83	5.16	4.92- 4.60	....	4.56	4.81
Missouri No 4 (car sample, 10 tons, run of mine, small car):							
Moisture	13.34	10.57	12.67	12.24	12.04	....	12.32
Ash	6.91	6.15	4.83	5.55	5.27	....	5.22
Sulphur	5.06	5.00	5.12	4.98	5.14	....	5.08
Texas No. 1 lignite (car sample from 21 tons):							
Moisture	32.58	33.50	34.70	....	....	33.50	34.10
Ash	10.84	10.75	11.20	....	....	10.36	10.78
Sulphur	.56	.56	.79	....	....	.63	.71
West Virginia No. 1 (car samples from 30 tons run of mine):							
Moisture	1.40	1.35	1.75	1.90	1.93	1.61	1.80
Ash	6.67	6.42	6.34	7.21	6.60	6.14	6.57
Sulphur	1.59	1.31	.90	.98	.88	.87	.91
West Virginia No. 2 (car sample from 11 tons run of mine):							
Moisture	1.98	1.87	1.95	2.01	1.73	....	1.90
Ash	9.08	8.10	7.86	9.96	8.22	....	8.68
Sulphur	4.20	3.75	3.48	2.71	3.38	....	3.19
West Virginia No. 3 (car sample from entire car run of mine):							
Moisture	2.90	2.21	2.29	2.54	2.25	....	2.36
Ash	8.19	8.32	10.23	11.04	9.75	....	10.34
Sulphur	.75	.80	1.06	1.36	.99	....	1.14
West Virginia No. 4 (car sample from 25 tons run of mine):							
Moisture	2.26	2.26	1.48	2.53	2.72	1.99	2.18
Ash	7.74	8.58	8.89	9.99	10.50	8.83	9.43
Sulphur	.85	1.26	.90	.96	.86	.79	.88
West Virginia No. 5 (car sample from 20 tons lump and nut):							
Moisture	2.82	3.08	1.45	2.11	2.43	....	2.00
Ash	10.45	10.37	10.10	10.28	10.72	....	10.37
Sulphur	1.00	1.13	.98	1.01	.90	....	.96
West Virginia No. 6 (car sample from 31 tons run of mine):							
Moisture	2.29	2.10	1.53	2.14-2.11	1.76-2.27	....	1.96
Ash	5.88	3.55	5.05	5.45-5.03	4.84-5.40	....	5.15
Sulphur	.73	.75	.65	.70- .64	.55- .88	....	.68

Table of results on coals of which three or more samples were taken at the testing plant—Continued.

	Mine samples.		Testing-plant samples.				Average of plant samples.
	A.	B.	Car.	Steam.	Coke.	Gas.	
West Virginia No. 7 (first car sample taken = 10 tons; second sample from 5 tons of remainder of car two months later, run of mine):							
Moisture	2.48	2.12	3.94–2.57	2.68	3.85	2.99	3.21
Ash	4.15	3.55	4.93–8.94	8.52	5.02	6.67	6.88
Sulphur	1.08	.90	1.16–1.13	1.52	1.36	.92	1.22
West Virginia No. 8 (car sample from 35 tons run of mine):							
Moisture	1.90	1.84	4.16	5.26	3.82	....	4.41
Ash	4.87	6.76	7.17	6.87	7.20	....	7.08
Sulphur	.64	.89	.90	.74	.89	....	.84
West Virginia No. 9 (car sample from 30 tons run of mine):							
Moisture	1.98	1.77	4.08	3.42	3.81	2.66	3.49
Ash	3.76	2.94	6.58	6.00	8.07	5.73	6.59
Sulphur	.85	.74	.77	.82	.83	1.00	.81
West Virginia No. 10 (car sample from 10 tons lump and nut):							
Moisture	2.94	2.63	1.75	1.74	1.62	....	1.70
Ash	3.62	3.13	4.58	6.19	5.87	....	5.38
Sulphur	.48	.57	.56	.59	.61	....	.59
West Virginia No. 11 (car sample from 10 tons run of mine):							
Moisture	2.21	3.05	4.07	4.85	5.35	....	4.76
Ash	5.25	4.57	11.12	10.48	9.95	....	10.52
Sulphur	.44	.50	.51	.47	.47	....	.48
West Virginia No. 12 (car sample from 40 tons run of mine):							
Moisture	1.92	3.48	1.72	1.58	1.53	1.43	1.57
Ash	4.39	3.90	6.87	4.83	6.16	6.45	6.08
Sulphur	.52	.73	.68	.59	.97	.95	.80

It was intended that the car sample should represent the average of the whole car, while the other samples stood for different portions of it. These would average about 5 tons each. In some cases the car sample was taken on only a part of the car. The large variation in the different samples in a few cases shows the irregularity in the coal in the car. The numerical average of all the testing-plant samples is given also. It of course averages the samples from the large amount with those from the smaller portions, and therefore does not stand for much, but in many cases it agrees fairly well with the car sample. As an illustration, West Virginia No. 5 shows an average percentage of ash of 10.37 and an extreme variation from this average of only 0.35 per cent. On the other hand, certain samples, such as Kansas No. 3, show considerable variation; in this case as high as 3 per cent from the average in one sample. It will be noted that the car sample is here a relatively small amount of coal, not much more than was taken for the steam and coke tests. It will be found that in most of those samples where considerable variation is shown that sulphur and ash are high and that the ash is present in the form of irregularly distributed slate and the pyrite in balls and seams. This leads to concentration of the heavier portions at the bottom of the car and makes any system of sampling which does not involve the handling of the whole carload unsatisfactory. This is shown further in the case of Kansas No. 5, where two samples were taken from the car, the first during the unloading of 7 tons and the second during the unloading of 30 tons. The average ash is 11.25; the ash in the larger carload sample, 11.31; in the small car sample, 10.54.

An experiment was made to test the character of the sampling on the carload of Indian Territory No. 3, a coal rather high in slate and pyrite. Duplicate samples were made at the same time and by the regular method. These samples, about 400 pounds each, numbered 1274 and 1274A, were separately reduced to the laboratory sample. The results are as follows:

Results of tests of duplicate samples of Indian Territory No. 3 coal.

	1274.	1274A.
Moisture	3.45	3.55
Ash	11.28	11.88
Sulphur	3.67	3.51

The agreement on this sample is fairly satisfactory, a difference of 0.60 per cent in ash with 11.50 per cent present being about as good as can be expected on high ash and sulphur coals.

Missouri No. 2 appeared to be very irregular in the distribution of slate and pyrites, which were present in lumps of considerable size. On this coal a series of duplicate samples were made in the following way: Two 400-pound samples were taken by the regular method, in the same way and at the same time, as the car was unloaded. Each 400-pound sample was then broken up, mixed, and divided by "quartering" till a 50-pound sample was obtained. The remainder from each large sample was again mixed and quartered to a second 50-pound sample. The four large samples thus obtained were then sent to the laboratory.

The 50-pound samples obtained from the first large sample are numbered 1 and 2; those from the second, 3 and 4.

Sample No. 1 was thoroughly mixed and then quartered. One quarter was run through the jaw crusher, which reduced it to about one-fourth inch. This portion was then mixed and further divided by quartering to about 6 pounds. This was then air dried and sampled in the usual way. All of the remainders thrown aside in obtaining this 6-pound sample were then mixed together, quartered, and one quarter was run through the crusher. This in turn was mixed and divided by quartering to about 6 pounds, this 6-pound portion being also air dried and sampled in the usual way. The first 6-pound sample was numbered 1348; the second, 1349.

Sample No. 2 was treated in the same way as the sample from bucket No. 1, except that one-half of the entire sample was put through the jaw crusher, instead of one-quarter. In obtaining the second 6-pound sample, one-half of all the remainders was likewise put through the crusher. These two samples were numbered 1350 and 1351.

Sample No. 3 was treated in exactly the same way as that in bucket No. 2. The two samples obtained from bucket No. 3 were numbered 1352 and 1353.

Sample No. 4. All of this sample was run through the crusher. This was then mixed and divided down to about 6 pounds. All of the remainders were again mixed together and then again divided down to about 6 pounds. These two samples were numbered 1354 and 1355.

The relation of these samples is shown below:

- Missouri No. 2 coal....
  - 400-pound sample....
    - Bucket No. 1 (50 lbs.)..
      - Laboratory sample No. 1348.
      - Laboratory sample No. 1349.
    - Bucket No. 2 (50 lbs.)..
      - Laboratory sample No. 1350.
      - Laboratory sample No. 1351.
  - 400-pound sample....
    - Bucket No. 3 (50 lbs.)..
      - Laboratory sample No. 1352.
      - Laboratory sample No. 1353.
    - Bucket No. 4 (50 lbs.)..
      - Laboratory sample No. 1354.
      - Laboratory sample No. 1355.

The analytical results were as follows:

Analyses of Missouri No. 2 coal.

	Laboratory sample number—							
	1348.	1349.	1350.	1351.	1352.	1353.	1354.	1355.
Loss on air drying............	2.56	1.37	1.80	1.92	3.21	3.36	2.24	1.67
Moisture	11.46	11.31	11.47	11.37	11.10	10.54	11.56	12.00
Ash	16.86	17.04	15.72	15.89	14.57	14.97	15.41	13.76
Sulphur	5.16	5.17	4.75	4.71	5.09	5.69	4.92	4.88

It will be noted that there is considerable difference in the air-drying loss, probably due to the fact that the portions were spread out to different thicknesses during the air drying. The results reduced to the samples as received, however, agree fairly well. The bottle containing the fine sample, No. 1353, was found to be cracked, which may account for its low percentage of moisture.

The average of the results for the eight samples is: Moisture, 11.35; ash, 15.53; sulphur, 5.03.

The average of the results for the first four samples is: Moisture, 11.40; ash, 16.38; sulphur, 4.95.

The average of the results for the second four samples is: Moisture, 11.30; ash, 14.68; sulphur, 5.14.

The averages of the results for the different pairs of samples are:

Average results of analyses of Missouri No. 2 coal.

	First pair.	Second pair.	Third pair.	Fourth pair.
Moisture	11.38	11.42	10.82	11.78
Ash	16.95	15.80	14.77	14.58
Sulphur	5.16	4.73	5.39	4.90

Samples No. 1354 and No. 1355 were the only ones which were entirely put through the crusher. The variation in ash shows that the effort to remix the 50-pound sample by means of a 14-inch spatula was not very successful.

The foregoing results show that with coals which run high in ash and sulphur and which contain irregularly distributed lumps of slate and pyrite, hand sampling gives only approximate results.

The particular coal used in this test was selected because it was considered a typical example of a difficult coal to sample, and it is highly probable that in most of the fuels tested much closer results would have been obtained.

In order to locate the most defective part of the process comparison may be made between the different groups.

It will be seen that the average of the first four parts, which represents the first of the two samples drawn from the car, differs widely in ash from the average of the second four. This shows that the method of taking the sample from the car is faulty. The differences between the averages of the two pairs from each large sample are not nearly so great, showing that the hand reduction, while not very satisfactory, is still not responsible for the major variations. The agreement between the individual samples in the pairs reduced in the laboratory is, with the exception of the last pair, fairly satisfactory. The last pair was the only one in which the whole sample was put through the crusher, and the variation is probably due to the insufficient remixing of the large amount of material. This would not occur in the ordinary method.

EXPERIMENTS ON THE MOISTURE IN COAL.

DATA ON AIR DRYING.

The method in use for the determination of moisture has been described. It soon became evident that the results left much to be desired, that different coals varied greatly in the rate and the amount of loss on air drying, and that for the same coal this rate and amount are dependent upon many conditions. Among these are the fineness of the sample, the amount of coal spread on a given area, the temperature and the humidity of the air, and the length of air drying. A record was kept of the results obtained upon a number of samples, together with a record of these various conditions. The results are given in the following table.

The first division of the table gives the original weight of the sample before air drying at one-fourth inch size, the number of hours dried, the percentage of loss in weight, and the temperature and humidity of the air at the beginning and end of the period of air drying.

The second division of the table gives the result of a series of experiments of a portion of the air-dried sample which had been crushed through the rolls to 20-mesh size. This second drying was conducted in 9-inch pans on which the coal was spread. The samples were weighed at intervals of approximately six, twenty-four, forty-eight, and seventy-two hours. The table gives the loss of weight between each set of weighings and the total percentage of loss shown by the last weighing. The humidity gives the percentage of saturation of the air as shown by observation of the wet and dry bulb thermometer taken in the laboratory at the time of the weighing. Notable variations in the fineness of the sample or of the time of drying are recorded in the table as side notes. For the sake of comparison, the determination of moisture in a duplicate portion of the 20-mesh sample, sampled without further air drying after reduction from the one-fourth inch, is added. This latter sample was ground to 60 mesh for the laboratory sample in the ordinary way.

Data on air drying.

Sample number.	Coarse sample, ¼-inch, dried on 22 by 26 inch trays.							20-mesh sample taken after the air drying at ¼-inch, dried on 9-inch pans (see Remarks).																Moisture determined at 105° C. in duplicate portion of 20-mesh sample crushed to 60 mesh.	Remarks.
			Initial.		Final.				At time of first weighing.		Dried for 6 hours.			Dried for 24 hours.			Dried for 48 hours.			Dried for 72 hours.					
	Original weight.	Hours dried.	Temperature.	Humidity.	Temperature.	Humidity.	Per cent loss.	Original weight.	Temperature.	Humidity.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Total per cent loss.		
			° C.		° C.				° C.		° C.			° C.			° C.			° C.					
1010[a]	....	....	....	....	....	....	....	91.3	....	(b)	....	(c)	1.86	....	(c)	0.11	....	....	....	20	74	2.41	4.38	11.27	
1011[a]	....	....	....	....	....	....	....	219.5	....	(b)	....	(c)	.50	....	(c)	1.58	....	....	....	20	74	2.32	4.40	11.08	10-mesh sample; time, 4 hours.
1012[a]	....	....	....	....	....	....	....	193.[illegible]	25	55	25	54	1.09	21	46	− .10	23	76	−0.10	....	....	....	.89	7.81	Do.
1012[a]	....	....	....	....	....	....	....	96.0	25	55	25	54	1.04	21	46	− .73	23	76	− .10	....	....	....	.21	....	Time, 3¼ hours.
1013[a]	....	....	....	....	....	....	....	204.9	25	55	25	54	.73	21	46	.00	23	76	.00	....	....	....	.73	9.68	10-mesh sample; time, 3 hours.
1013[a]	....	....	....	....	....	....	....	90.6	25	55	25	54	2.31	21	46	− .55	23	76	− .22	....	....	....	1.54	....	Time, 2 hours.
1016[a]	....	....	....	....	....	....	....	146.6	20	68	....	....	....	24	67	.13	....	....	....	....	....	....	.13	5.48	
1017[a]	....	....	....	....	....	....	....	88.3	30	64	24	70	1.13	20	67	− .34	27	40	1.03	19	76	− .57	1.25	2.44	
1018[a]	....	....	....	....	....	....	....	88.1	30	64	24	70	1.00	20	67	− .45	27	46	1.25	19	76	− .68	1.12	2.91	Time of last two, 30 and 46 hours.
1019[a]	....	....	....	....	....	....	....	95.0	30	64	24	70	.84	20	67	− .21	27	46	1.05	19	76	− .63	1.05	2.36	
1020[a]	....	....	....	....	....	....	....	109.1	30	64	24	70	1.00	20	67	− .37	27	46	1.00	19	76	− .45	1.18	3.50	
1021[a]	....	....	....	....	....	....	....	42.8	21	70	27	45	2.10	18	75	−1.00	....	....	....	....	....	....	1.10	5.25	
1023[a]	....	....	....	....	....	....	....	66.1	26	50	....	....	....	18	77	2.12	27	51	2.12	22	77	−2.12	2.12	11.38	
1024[a]	....	....	....	....	....	....	....	68.6	26	50	....	....	....	18	77	1.86	27	51	2.28	22	77	−2.14	2.00	12.17	Third and fourth weights at 19 and 27 hours.
1025[a]	....	....	....	....	....	....	....	77.4	26	50	....	....	....	18	77	2.15	27	51	2.25	22	77	−1.90	2.50	10.92	Do.
1026[a]	....	....	....	....	....	....	....	79.2	26	50	....	....	....	18	77	2.00	27	51	2.25	22	77	−2.25	2.00	11.00	Third and fourth weights at 18 and 26 hours.
1027[a]	....	....	....	....	....	....	....	157.1	26	66	29	63	.96	22	76	.06	24	82	− .32	....	....	....	.70	9.13	10-mesh sample.
1028[a]	....	....	....	....	....	....	....	168.2	26	66	29	63	1.65	22	76	.35	24	82	− .06	....	....	....	1.94	9.68	Do.
1029[a]	....	....	....	....	....	....	....	142.3	25	67	29	63	2.11	22	76	.64	24	82	− .08	....	....	....	2.67	9.40	Do.
1030[a]	....	....	....	....	....	....	....	217.5	26	72	31	55	1.05	24	82	− .23	31	66	.14	....	....	....	.96	.95	Do.
1031[a]	....	....	....	....	....	....	....	217.8	26	72	31	55	.83	24	82	− .18	31	66	.05	....	....	....	.70	.80	Do.
1034[a]	....	....	....	....	....	....	....	189.9	25	80	....	....	....	26	68	.74	27	74	− .09	25	63	.09	.74	1.46	Do.

[a] Coarse sample, not air dried.

[b] Rainy.

[c] Damp.

Data on air drying—Continued.

Sample number.	Coarse sample, ¼ inch, dried on 22 by 26 inch trays.							20 mesh sample taken after the air drying at ¼-inch, dried on 8-inch pans (see Remarks).																Moisture determined at 105° C. in air-dried 20-mesh sample.	Remarks.
	Original weight.	Hours dried.	Initial.		Final.		Per cent loss.	Original weight.	At time of first weighing.		Dried for 6 hours.			Dried for 24 hours.			Dried for 48 hours.			Dried for 72 hours.			Total per cent loss.		
			Temperature.	Humidity.	Temperature.	Humidity.			Temperature.	Humidity.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.			
			° C.		° C.				° C.		° C.			° C.			° C.			° C.					
1036[a]..	......	......	......	......	......	......	......	212.5	25	80	......	......	......	26	68	1.83	27	74	0.00	25	63	0.00	2.01	1.01	10-mesh sample.
1037[a]..	......	......	......	......	......	......	......	48.5	25	80	......	......	......	26	68	1.80	27	74	.20	25	63	.00	2.00	1.34	20-mesh sample.
1040[a]..	......	......	......	......	......	......	......	196.9	29	67	......	......	......	27	74	.08	25	66	.05	22	64	.10	[illegible]	.85	10-mesh sample.
1040[a]..	......	......	......	......	......	......	......	43.8	29	67	......	......	......	27	74	.00	25	61	.00	22	64	.40	.40		20-mesh sample.
1043[a]..	......	......	......	......	......	......	......	190.8	29	67	......	......	......	27	74	2.87	25	63	.10	22	64	.26	3.38	4.60	10-mesh sample.
1045[a]..	......	......	......	......	......	......	......	103.0	29	67	......	......	......	25	63	.68				18	64	.10	.78	1.05	
1046[a]..	......	......	......	......	......	......	......	196.4	29	67	......	......	......	25	63	.40				25	65	.00	.40	.77	Dry.
1046[a]..	......	......	......	......	......	......	......	56.0	29	67	......	......	......	25	63	.00				25	65	.00	.00		20-mesh sample.
1052[a]..	......	......	......	......	......	......	......	113.7	28	54	......	......	......	22	74	.04	24	70	.10	23	60	.00	.14	[illegible]	10-mesh sample.
1052[a]..	......	......	......	......	......	......	......	54.8	28	54	......	......	......	22	74	.00	24	70	.20	23	60	.00	.20		20-mesh sample.
1056[a]..	......	......	......	......	......	......	......	69.1	28	54	......	......	......	22	74	1.43	24	70	.00	23	60	.00	1.43		Dry.
1056[a]..	......	......	......	......	......	......	......	113.3	28	53	......	......	......	22	72	1.00	23	70	.00	23	60	.00	1.00	8.55	10-mesh sample.
1061[a]..	......	......	......	......	......	......	......	56.5	27	52	27	48	1.00	23	60	.18							1.42	9.08	Time 4 hours.
1061...	488.5	24	27	52	23	60	1.50	......	......	......	......	......	......												
1068[a]..	......	......	......	......	......	......	......	191.9	17	70	......	......	......	16	71	1.86	18	65	.73				2.90	.80	10-mesh sample.
1071[a]..	......	......	......	......	......	......	......	170.3	17	70	......	......	......	16	71	.28	18	65	.00				.28	1.40	Dry.
1075[a]..	......	......	......	......	......	......	......	170.1	17	70	......	......	......	16	71	.45	18	65	.06				.51	[illegible]	
1079[a]..	......	......	......	......	......	......	......	239.1	17	70	......	......	......	16	71	.58	18	65	.08				.66	[illegible]	
1082[a]..	......	......	......	......	......	......	......	250.1	24	75	......	......	......	17	70	1.40	16	71	.28				1.68	[illegible]	
1122...	989.2	24	28	75	25	81	2.00	136.6	25	82	......	......	.52	81	68	.65	......						1.17	[illegible]	
1126...	2,313.0	24	25	82	31	63	5.00	209.8	25	82	......	......	.14	81	68	.38							.52	[illegible]	
1138...	2,747.0	24	30	70	26	69	3.30	158.2	23	69	25	45	.63	20	66	.25	......						.88	[illegible]	
1152...	3,457.0	48	20	66	21	60	7.10	342.2	21	60	......	......	......	28	71	1.07	25	68	.63				1.70	[illegible]	

[a] Coarse sample, not air dried.

Data on air drying—Continued.

Sample number.	Coarse sample, ¼-inch, dried on 22 by 26 inch trays.							20-mesh sample taken after the air drying at ¼-inch, dried on 9-inch pans (see Remarks).															Total per cent loss.	Moisture determined at 105° C. in duplicate portion of 20-mesh sample crushed to 60 mesh.	Remarks.
	Original weight.	Hours dried.	Initial.		Final.		Per cent loss.	Original weight.	At time of first weighing.		Dried for 6 hours.			Dried for 24 hours.			Dried for 48 hours.			Dried for 72 hours.					
			Temperature.	Humidity.	Temperature.	Humidity.			Temperature.	Humidity.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.			
			° C.		° C.				° C.		° C.			° C.			° C.			° C.					
1160...	1,228.0	24	21	55	23	71	1.50	279.6	23	70	25	68	0.21	23	79	−0.35	...	...	...	...	...	...	−0.14	0.74	
1184...	2,097.0	48	17	46	27	55	2.80	127.6	27	49	...	...	...	25	68	1.57	...	...	...	...	...	...	1.57	1.70	
1201...	1,067.0	48	26	47	23	77	.80	271.5	23	78	29	63	.44	18	72	− .32	...	...	...	...	...	...	.12	1.55	
1213...	2,853.0	24	18	72	18	63	.40	404.2	18	62	22	46	.30	19	53	− .05	...	...	...	...	...	...	.25	1.35	
1225...	1,299.0	24	19	54	12	78	.80	366.6	12	78	18	56	.41	20	50	− .27	...	...	...	...	...	...	.14	2.58	
1245...	5,094.0	48	20	50	17	63	3.40	176.6	17	62	...	...	...	...	...	...	19	61	1.47	...	...	...	1.47	2.08	
1252...	3,846.0	48	20	50	17	63	1.30	145.8	17	62	...	...	...	...	...	...	19	61	.21	...	...	...	.21	1.00	
1261...	670.2	24	17	43	14	70	3.70	219.0	14	71	...	...	...	19	34	2.27	...	...	...	19	34	2.15	4.42	6.28	
1262...	3,668.0	24	24	49	19	61	.50	395.3	19	60	23	48	.48	...	...	.05	...	...	...	...	...	...	.53	.98	
1274...	4.290.0	24	17	43	14	69	1.20	421.9	14	71	...	...	...	19	34	.80	...	...	...	19	34	.69	1.49	3.45	
1278...	4,671.0	24	14	68	19	34	1.60	453.6	19	34	...	...	...	...	...	...	19	34	3.50	...	...	...	3.50	10.86	
1296...	719.4	24	20	44	13	49	1.40	228.7	13	49	...	...	...	19	49	.46	...	...	...	...	...	...	.46	.80	
1297...	2,750.0	24	14	45	13	49	.80	328.8	13	49	...	...	...	19	49	.39	...	...	...	...	...	...	.39	.65	
1307...	756.3	24	13	49	19	49	2.90	272.4	19	49	...	...	...	24	42	1.10	...	...	...	...	...	...	1.10	8.13	
1308...	712.2	24	13	49	19	49	.50	278.2	19	49	...	...	...	...	...	...	18	64	.10	...	...	...	.10	1.46	
1318...	3,016.0	48	24	42	18	64	2.70	345.9	18	64	...	...	...	15	61	.55	13	58	.49	...	...	...	1.04	5.96	
1331...	4,192.0	24	15	61	13	58	1.10	263.9	13	58	...	...	...	21	38	.37	...	...	...	15	52	.00	.37	1.28	Time of last weighing, 172 hours.
1347...	2,165.0	24	21	46	19	57	3.20	200.7	19	57	...	...	...	...	...	...	...	...	...	14	60	4.53	4.53	5.21	Time of last weighing, 120 hours.
1348...	3,741.0	24	21	46	19	57	2.60	450.9	18	64	...	...	...	...	...	...	...	...	...	15	52	4.65	4.65	9.14	Do.
1364...	2,706.0	48	17	55	17	55	1.10	195.3	17	55	...	...	...	...	...	...	14	60	.20	...	...	...	.20	.62	
1416...	3,592.0	170	12	67	29	43	24.10	165.8	25	43	...	...	...	...	...	...	...	...	...	19	49	1.93	1.93	16.70	Time of last weighing, 98 hours.
1433...	2,110.0	24	16	54	14	60	6.80	251.3	14	60	...	...	...	...	...	...	25	43	4.58	12	67	.31	4.89	9.22	Do.
1484...	720.4	72	16	54	25	50	9.80	242.5	19	57	...	...	...	25	43	1.23	...	...	...	14	50	1.73	2.96	4.52	Time of last weighing, 144 hours.
1437...	1,405.0	24	17	46	19	41	4.50	309.1	19	57	...	...	...	25	43	2.68	...	...	...	14	50	4.79	7.47	10.03	Time of last weighing, 176 hours.

Data on air drying—Continued.

Sample number.	Coarse sample, ¼-inch, dried on 22 by 26 inch trays.							20-mesh sample taken after the air drying at ¼-inch, dried on 9-inch pans (see Remarks).																Moisture determined at 105° C. in duplicate portion of 20-mesh sample crushed to 60 mesh.	Remarks.
	Original weight.	Hours dried.	Initial.		Final.		Per cent loss.	Original weight.	At time of first weighing.		Dried for 6 hours.			Dried for 24 hours.			Dried for 48 hours.			Dried for 72 hours.			Total per cent loss.		
			Temperature.	Humidity.	Temperature.	Humidity.			Temperature.	Humidity.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.	Temperature.	Humidity.	Per cent loss since last weighing.			
			° C.		° C.				° C.		° C.			° C.			° C.			° C.					
1456...	1,258.0	72	19	49	15	36	24.60	241.5	15	36	....	....	....	....	....	....	8	63	1.25	15	43	1.15	2.40	13.40	Weights at 168 and 246 hours.
1461...	2,783.0	48	19	49	15	36	2.70	336.8	15	36	....	....	....	....	....	....	8	63	1.26	15	43	.72	1.98	5.36	Do.
1470...	721.4	48	10	65	15	43	1.40	243.8	15	43	....	....	....	....	....	....	8	63	.21	8	50	.20	.41	4.91	Weights at 96 and 120 hours.
1471...	721.5	48	10	65	15	43	1.10	273.5	15	43	....	....	....	....	....	....	8	63	-.07	8	63	.43	.36	.65	Weights at 96 and 175 hours.
1472...	698.0	48	10	65	15	43	3.30	244.8	15	43	....	....	....	....	....	....	8	63	.12	15	43	.16	.28	.80	Weights at 96 and 173 hours.
1473...	705.9	48	10	65	15	43	3.50	222.8	15	43	....	....	....	....	....	....	8	63	.94	15	43	.27	1.21	3.57	Weights at 96 and 172 hours.
1474...	689.7	48	10	65	15	43	1.20	249.8	15	43	....	....	....	....	....	....	8	63	-.12	8	50	.12	.00	1.92	Weights at 96 and 120 hours.
1479...	1,831.0	72	10	65	14	60	6.00	276.7	15	43	....	....	....	....	....	....	8	63	1.33	15	43	.40	1.73	17.69	Weights at 72 and 144 hours.
1495...	2,874.0	48	12	48	8	63	3.60	394.8	8	63	....	....	....	....	....	....	15	48	.89	11	46	1.92	2.81	6.24	Weights at 72 and 480 hours.
1506...	2,013.0	48	13	58	8	55	2.20	188.6	8	50	....	....	....	....	....	....	15	43	.32	11	46	1.85	2.17	5.85	Lost weight at 468 hours.
1507...	3,650.0	48	13	58	8	55	3.00	178.5	8	50	....	....	....	....	....	....	15	43	3.18	9	64	1.24	4.42	8.66	Lost weight at 480 hours.
1515...	2,209.0	48	11	55	10	53	2.60	331.9	10	53	....	....	....	....	....	....	....	....	....	9	64	.30	.30	1.60	Lost weight at 380 hours.
1516...	1,880.0	48	11	55	10	53	7.70	269.6	10	53	....	....	....	....	....	....	....	....	....	9	64	4.56	4.56	5.39	Do.
1523...	a 3,512.0	48	10	58	9	64	6.00	330.6	9	64	....	....	....	....	....	....	....	....	....	11	46	.78	.78	18.49	Lost weight at 312 hours.
1539...	a 686.5	72	9	64	2	69	2.80	248.1	2	69	....	....	....	....	....	....	....	....	....	4	71	.60	.60	2.54	Lost weight at 240 hours.
1542...	a 3,857.0	72	6	60	2	69	3.00	366.6	5	71	....	....	....	....	....	....	....	....	....	10	53	-.10	-.10	.82	Lost weight at 212 hours.
1557...	a 5,399.0	144	1	83	8	63	9.80	154.7	8	68	....	....	....	....	....	....	9	64	2.58	....	....	....	2.58	5.13	
1558...	a 4,667.0	48	1	83	3	70	2.10	325.5	3	70	....	....	....	....	....	....	....	....	....	11	46	.24	.24	.67	
1561...	a 3,705.0	24	3	70	3	70	3.10	282.1	3	70	....	....	....	....	....	....	....	....	....	9	64	.24	.24	1.01	
1567...	a 3,184.0	96	3	70	8	63	2.80	328.9	8	63	....	....	....	....	....	....	9	64	.82	....	....	....	.82	1.84	
1570...	a 3,896.0	96	3	70	8	63	10.40	136.6	3	70	....	....	....	....	....	....	....	....	....	9	64	1.24	1.24	4.25	Lost weight at 144 hours.

[a] Dried by warming over combustion furnace for about two hours. Sample warm to hand.

The following facts are established by these records: That the loss by air drying is greater the finer the sample is reduced, the 20-mesh portion in nearly all cases showing a considerable additional loss over the quarter-inch mesh. This loss might, however, have occurred with the coarser sample had sufficient time been given. A comparison with the temperature and humidity records shows that a sample air dry for one set of conditions is not so for a different set; this is clearly shown in samples 1012, 1013, 1021, 1030, 1031, 1056, and 1160, in which a decided increase in the humidity of the air during the process resulted in a marked gain of weight, indicated by the minus sign in the table.

The fact that the apparently nearly air-dry sample in the coarse condition will suffer a further rapid and considerable loss of moisture on being ground to fine powder makes evident the importance of proper precautions in the preparation of the final sample. In the work at the testing laboratory this final grinding was done as rapidly as possible, the time averaging about six minutes, and the samples were transferred immediately to bottles securely closed with rubber stoppers.

Though the final grinding required only a very few minutes, it is evident that some moisture was lost in the preparation of the sample. Where the final grinding is done in an open mortar instead of with rolls and on a bucking plate the time required would be greater and the moisture lost proportionately larger, especially where the air is dry and warm. An experiment made in the laboratory at Columbus, Ohio, shows this well.

A sample of Hocking coal was air dried twenty-two hours with a loss of 8.45 per cent. It was then crushed, ground, and sifted through a 60-mesh sieve. The total time required to prepare the fine sample was about twenty-five minutes and the whole of the work was done in an open hand mortar. A second portion of the same sample, after air drying, was immediately transferred to a ball mill and ground in a closed jar to fine powder which was at once transferred to a glass jar and sealed. Moisture determinations were made in the two samples; the mortar sample showed 3.85 per cent. The ball-mill sample showed 4.62 per cent, or a loss of 0.77 per cent due to the open grinding of the sample.

Of course it is highly improbable that the rapid preparation of the testing-plant samples involved any such loss as this.

As a continuation of the foregoing experiment 10 grams of the 60-mesh sample were spread out on a large watch glass and allowed to air dry in the laboratory and the weight recorded at short intervals. The air of the laboratory was warm and dry.

Loss of moisture in air drying.

Time exposed.		Loss of weight.
Hrs.	*min.*	*Per cent.*
0	10	0. 246
0	24	0. 358
0	39	0. 561
0	54	0. 686
0	68	0. 701
3	54	1. 296
4	39	1. 411
5	49	1. 441
22	59	1. 796
69	59	1. 236

The gain during the last period (0.560 per cent) was due to a change in the weather to damp and rainy conditions.

It may be noted, finally, as a practical result from the foregoing observations, that the method, frequently used, of taking a sample coal from the mine or car and sending it to a laboratory in an ordinary box or bag will not enable the chemist to tell anything about the moisture originally present in the coal.

DETERMINATION OF MOISTURE IN THE LABORATORY SAMPLE.

The air bath in which the samples were dried was of course filled with the moist air of the laboratory, and the work was done during a part of the year in which the absolute amount of moisture in the air was large. It was highly probable that drying under other conditions would give different results. A number of samples were sent to Doctor Hillebrand, in Washington, who at a later date made a series of determinations of moisture, both in the toluene bath and in vacuo over sulphuric acid. The samples were dried in vacuo for forty-eight hours, and in some cases for seven days.

The following table gives the results obtained by Doctor Hillebrand in comparison with those obtained at the fuel-testing laboratory at St. Louis.

Moisture in laboratory samples as determined at fuel-testing laboratory at St. Louis, and as determined by Dr. W. F. Hillebrand at Washington, D. C.

Sample number.	Fuel-testing laboratory.	Doctor Hillebrand.	
		Air oven at 105°.	In vacuo over sulphuric acid for 48 hours.
1114	1.17	1.46	1.51
1122	2.23	3.14	3.42
1126	3.50	4.64	4.87
1138	3.87	4.90	5.10
1152	5.31	6.68	6.86
1160	.74	1.16	1.20
1184	1.70	2.29	2.49
1201	1.55	2.56	2.80
1213	1.35	1.70	1.95
1225	2.58	3.61	3.90
1245	2.08	3.12	3.25
1252	1.00	1.33	1.51
1261	6.28	7.63	7.87
1262	.98	1.45	1.61
1274	3.45	3.96	4.34
1278	10.86	11.93	12.15
1279a	15.42	15.20	15.56
1296	.80	1.15	1.14
1297	.65	1.34	1.47
1298	9.05	9.96	10.63
1307	8.13	8.39	8.80
1308	1.46	1.67	1.74
1318	5.96	6.87	7.37
1331	1.28	1.61	1.64
1347	5.21	6.36	6.65
1347	5.21	6.36	6.65
1348	9.14	10.38 [a] 10.51	11.00
1364	.64	.96	1.01
1416	16.70	16.94 [a] 16.86	17.71 [b] 17.99
1417	11.40	13.19 [a] 13.16	13.57 [b] 13.64
1433	9.22	11.84	12.17
1434	4.52	5.71	5.95
1437	10.03	11.33	11.64
1456	13.40	13.13	13.86 [b] 13.98
1461	5.36	5.77	6.17
1469	5.50	5.76	6.10
1470 [c]	4.91	4.63	5.25
1471	.65	.77	.99
1472	.80	.86	1.10
1473	3.57	3.65	4.45
1474	1.92	2.31	2.56
1479	17.69	17.85	18.45 [b] 18.58
1481	6.25	6.31	6.41
1495	6.24	6.57	6.95
1506	5.85	6.24	6.59
1507	8.66	9.00	9.32
1515	1.61	1.61	1.71
1516	5.39	6.00	6.15
1523	13.49	13.75	14.50
1539	2.54	2.58	2.81
1542	.82	.95	1.05
1549	5.07	7.10	7.49
1557	5.13	6.24	6.55
1558	.67	1.23	1.43
1561	1.01	1.74	1.92
1567	1.84	2.51	2.79
1570	4.25	5.03	5.36
1595	.76	1.22	1.56

[a] Only 1 crucible in bath at a time. In all other determinations 3 crucibles were in the bath at a time.
[b] In vacuo over sulphuric acid for 7 days.
[c] Stopper out of bottle when mailing case opened by Doctor Hillebrand.

A comparison of results in the foregoing table shows not only that in most all cases there was a very decided increase in the amount of moisture when the sample was dried in vacuo over sulphuric acid, but also that the results obtained by Doctor Hillebrand in an air oven at 105° were in most cases in excess and sometimes very considerably in excess of those yielded by the same samples in St. Louis, the difference amounting in several instances to over 1 per cent.

It is hardly probable that such differences as are shown can be the result of errors in manipulation. In all cases the results in the testing laboratory were the average of duplicates and in some cases of several determinations, usually quite concordant. As an example, in sample 1261 the result reported 6.28 is the average of four determinations, as follows: 6.21, 6.24, 6.32, and 6.33. On the same sample the percentage of moisture as found by Doctor Hillebrand some time later was 7.63 in the toluene bath and 7.87 in vacuo over sulphuric acid.

The explanation of these differences, in our opinion, is to be sought for among the following causes:

In the first place, the samples sent to Doctor Hillebrand were bottled immediately after grinding and were not opened until the determination was made. I am informed by Doctor Hillebrand that the samples used in his determination were weighed directly from the bottles, without pouring out and mixing the contents. In our work it was the custom to pour out the sample, mix it rapidly, and then weigh out the portion for analysis from different parts. This was done, as has already been explained, to secure uniformity in the treatment of all the portions weighed out for the different determinations. There would very likely be a resultant loss of moisture in this process, which might cause our results to run low. However, a comparison of the differences with the record showing approximately the number of times that the testing-plant sample had been opened and handled previous to the determination of the moisture does not show any relation between the moisture differences and the extent to which the sample was exposed. Duplicate determinations made on the same samples at the beginning of the series of determinations and after several portions had been weighed out showed practically identical results.

In the second place, there might be marked differences in the moisture in the air bath during the drying, owing to the widely different humidity conditions in the two laboratories and possibly in the kind of air baths used. This makes it of interest to test the effect of drying coal in air containing various amounts of moisture.

The following experiments on some of the samples were made in the metallurgical laboratory at Columbus, Ohio. A special air bath was designed, in which small Erlenmeyer flasks could be maintained at a temperature of 105°, and air which previously had been passed through any desired liquid was passed through them. Samples of coal were weighed in these flasks and flask and coal were weighed together, and, after drying, reweighed and the loss determined. As the flasks were closed all the time the influence of the air of the laboratory was eliminated.

The following results may be noted: Sample No. 1549, dried for one hour in air saturated with moisture by passing through water at 30° C., showed a loss of weight of 5.69 per cent. The loss was constant on redrying under same conditions. The same coal dried forty minutes in air passed through concentrated sulphuric acid showed a loss in weight of 6.27 per cent. The temperature in both cases was 105°.

The same sample was returned to bath and heated thirty minutes more in air which had passed through water at 30° C. The gain in weight was 0.49 per cent. This experiment shows that coal dried in air dehydrated in sulphuric acid will rapidly absorb moisture from air saturated at 30° and heated to a temperature of 105° C.

Further tests are given in the following table. In all cases the sample was dried to constant weight, first in air passed through sulphuric acid. It was then returned to the bath, the temperature being raised to 100°–105°, and air which had passed through water at the degree indicated was passed over the coal.

Experiments in drying coal.

	Number of sample.		
	1556.	1558.	1557.
Loss with sulphuric acid	0.0415	0.0100	0.1025
Gain in weight, water at 15°	.0035	.0020	.0062
Loss with sulphuric acid	.0420	.0095	.1025
Gain with water at 20°	.0055	.0060	.0085
	1529.	1534.	1569.
Dried in air saturated at 20°; loss	14.05	1.35	6.00
Further dried with acid; loss	.45	.15	.55
Further dried in air saturated at 20°; gain	.60	....	.50

From the above experiments it is evident that there may be marked differences in the figure obtained from moisture where the air in the oven differs in moisture contents, even if the temperature is always 105°, but it hardly seems probable that differences as large as those found could be accounted for in this way. It is, however, desirable that any method for the determination of moisture should eliminate this cause of variation by drying the air in which the sample is heated.

The third possible cause for variation is alteration in the moisture contents of the coal itself. The bottle containing the sample was closed by rubber stoppers, and it is difficult to see how it could have received moisture from outside, nor is it probable that it could have gained moisture in this way, though loss of moisture might be expected. Any change in moisture must therefore have come from internal changes in the composition of the sample itself. A single experiment made on a sample of coal ground to 60 mesh and sealed in a glass jar indicated the possibility of such change. The results are as follows:

The moisture was determined in air dried by sulphuric acid.

Moisture in sample immediately after preparation, 4.93 per cent; duplicate, 4.98 per cent.

Moisture in same sample after standing closely sealed for ten days, 5.24, 5.22, 5.28.

Moisture in same sample after standing one month, 5.35, 5.51, 5.41.

Further experiments on this matter are highly desirable and will be undertaken in connection with the work of the laboratory.

LABORATORY TESTS FOR COKING PROPERTIES.

Many of the mine samples were tested in the laboratory in order to determine the cementing property of the coal. The tests were made as follows: One part of the finely ground sample was thoroughly mixed with two parts of ground silica in a small mortar. A portion of the mixture was put into a small rectangular platinum box, one-quarter of an inch wide, one-quarter of an inch deep, and 2 inches long. The box was provided with a closely fitting platinum cover. After the box was filled with the mixture, it was struck off even with a spatula and the cover was fitted on. The box was then heated over the flame of a Bunsen burner until the volatile matter was completely expelled and then, after partial cooling, dropped into a beaker of water. The box was then opened and the contents were examined. The condition of the material varied according to the character of the coal, ranging from a loose powder without any adhesion up to firm bars of coke. Bars which were firm enough to permit removal from the box entire were further tested for their breaking strength by supporting the ends upon two metal pegs, 1½ inches apart, and suspending a small copper bucket from the middle of the bar. Shot was then poured into the bucket until the bar broke. The weight of the bucket and shot was taken as the strength of the bar.

According to the results of the above test, the coals were graded as follows:

Result 1. No adhesion, only loose powder remaining after test.
Result 2. Slight adhesion, but no bar produced.
Result 3. A bar produced, but not firm enough to stand removal from box.
Result 4. Well-formed bar, but broke under weight of empty bucket.
Result 5. The bar stood a weight of —— grams before breaking.

Where the bar was firm enough to be tested by the weight, the individual results did not always agree very closely, so the average of several was generally taken.

The following table gives a comparison between the results of tests at the coke ovens and the grading of the mine samples by the foregoing test:

Comparison of the results of laboratory coking tests with the results of tests made at the coke ovens at the testing plant.

Name of the coal.	Result of laboratory test on mine sample (grade).	Result of coking tests on the coal in the coke ovens.
Alabama No. 1	3	Coke from raw coal light and spongy.
Alabama No. 2	3	No coke produced.
Arkansas No. 1	[a]313	Do.
Arkansas No. 2	4	Do.
Illinois No. 1	2	Small coke and ash.
Illinois No. 2	2	Hard and soft coke, mixed, obtained from washed coal.
Illinois No. 3	2	No coke from raw coal; coke from washed coal, very brittle.
Indian Territory No. 1	4	No coke obtained.
Indian Territory No. 2	3	Coke from raw coal soft; coke from washed coal hard.
Indian Territory No. 3	3	No coke obtained.
Indian Territory No. 5	1	Some small coke, light and soft and fritted together.
Iowa No. 1	1	Brittle coke obtained from washed coal.
Kansas No. 1	2	No coke produced.
Kansas No. 2	2	Do.
Kansas No. 2	2	Small portion of the charge coked.
Missouri No. 2	3	Brittle coke obtained from washed coal.
West Virginia No. 1	3	Coke obtained; fair.
West Virginia No. 2	3	Coke obtained, of good quality.
West Virginia No. 3	3	Coke obtained, gray.
West Virginia No. 4	4	Coke obtained, good quality.
West Virginia No. 5	3	Do.
West Virginia No. 6	[a]300	Coke obtained, gray and light.
West Virginia No. 7	[a]370	Coke obtained, good quality.
West Virginia No. 8	[a]390	Coke obtained, hard and of good color.
West Virginia No. 9	3	Coke obtained, fair quality.
West Virginia No. 10	[a]450	Coke obtained, good coke.
West Virginia No. 11	[a]290	No coke obtained.
West Virginia No. 12	[a]300	Coke obtained, fair quality.

[a] Grams.

In classifying the coals according to the foregoing test, those graded 1 and 2 were called noncoking; those graded 3, probably coking; and those graded 4 and 5, coking coals.

It will be seen from the table that tests at the ovens gave results which did not always correspond to the predictions made from the grading of the mine sample. In many of the cases there was fair agreement, but there are three or four marked failures to agree. In some cases this may have been due to the fact that the coal was washed before going to the oven. The results on the mine samples of Illinois No. 3 and Iowa No. 1 indicate that they are noncoking coals. A brittle coke was obtained from these coals after washing, but a test of Illinois No. 3 unwashed resulted in a failure to produce coke in the oven.

On the other hand, while the laboratory test would indicate that Arkansas Nos. 1 and 2, Indian Territory No. 1, and West Virginia No. 11 are coking coals, the tests in the oven did not result in the production of coke.

[For index to report see end of Part III.]

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